UNITED STATES BUREAU OF EDUCATION
BULLETIN, 1909, NO. 10 - - - - - - - WHOLE NUMBER 420

EDUCATION FOR EFFICIENCY IN RAILROAD SERVICE

By J. SHIRLEY EATON
FORMERLY STATISTICIAN LEHIGH VALLEY RAILROAD

WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

CONTENTS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., December 2, 1909.

SIR: I have the honor to transmit herewith a monograph on the subject, Education for Efficiency in Railroad Service, by Mr. J. Shirley Eaton, which is intended for publication in the Bulletin of this Bureau.

The subject of educational preparation for definite occupations in life, and particularly for the several trades, is under serious discussion in this country. The relation of trade education to general education is one of the important aspects of that question. This relation was summed up by President Nicholas Murray Butler in his Introduction to Paulsen's German Universities (1895) in the saying: "What science and practical life alike need is not narrow men, but broad men sharpened to a point." This monograph concerns itself with the sharpening of young men to the point of efficiency in railroad service. It lays striking emphasis upon the need of breadth, but devotes attention mainly to the sharpening process.

Within the field of training for a specific industry, one of the most urgent questions is that concerning the relation of industrial training in schools to industrial training by apprenticeship. I desire to emphasize anew the importance of this question. It was treated by the late President Carroll D. Wright in his monograph on The Apprenticeship System in its Relation to Industrial Education, published in the Bulletin of this Bureau in 1908. Mr. Eaton's monograph throws additional light upon this question.

While Mr. Eaton is alone responsible for the personal opinions expressed in the following pages, I wish to call especial attention to the information which is here brought together and the author's treatment of this information, as worthy of serious consideration on the part of those who approach industrial education from the side of the industries and equally on the part of those who approach it from the side of general education.

Very respectfully,

ELMER ELLSWORTH BROWN,
Commissioner.

The SECRETARY OF THE INTERIOR.

FOREWORD.

When the writer, nine years ago, investigated for the Bureau of Education the subject of education for railroad service, the whole matter was in a very indefinite status. The monograph published at that time was little more than a collation of widely diverse opinions of railroad men. The advance made in the present decade is very surprising to those who may not be informed. Ideas of practical men on the subject are now less indefinite and conflicting. The relation between education and efficiency in railroad service is coming to be generally conceded. The most successful managers have seized on its financial import, and in their fiscal policies and operating organizations are giving it recognition. The large educational value of the railroad service itself is being turned to systematic practical account, and the value of educational agencies in preparing for specific industrial efficiency is better understood. The matter has reached the stage of devising best ways and means of applying principles now coming to be generally accepted by the most practical men. In a few notable instances of railroad and educational practice very distinct departures have been made.

The railroad service in the United States will shortly reach a total of 2,000,000 men. It is the largest and most highly organized example of associate effort in an epoch conspicuous for industrial and commercial concentration. In this view, the methods here evolved for preserving the proper balance between individual and group efficiency at any one time, and so of assuring the largest continuing effectiveness of the whole working body for the longest period of time—these methods take on especial significance. Among such methods, education in a broad sense must always be a large factor.

The review of the subject here given is not intended to be statistical. The schools and railroads described have been cited merely in illustration of the particular methods which their practice typifies.

EDUCATION FOR EFFICIENCY IN RAILROAD SERVICE.

I. PREPARATION AND EFFICIENCY.

Preparation is the process of making the tool. On the materialistic side the difference between the civilized man and the uncivilized man is, at the last analysis, a difference of tools. In shop practice it is an axiom that the greater the proportion of the total outlay of production which is efficiently devoted to the making of the jig or tool of manufacture, the less will be the final cost of the output. The education of the railroad man is his preparation for added efficiency; it is the time and resources which go into the jig or tool of special skill. Within reason, the more of a certain aggregate of time and resources which is spent on the preparation to do the work effectively, the larger the yield per year of time and per dollar of resources, including all that was spent in the course of preparation; but it must be real preparation.

Preparation is the process of passing from awkward effort to efficient effort. Practical railroad men recognize quickly the difference between skill and nonskill. To a very large degree they believe that skill can be acquired by preparation of some kind, but they have differed widely as to the best methods for this preparation and the extent to which, by acquisition, we may add to natural ability.

Skill in any particular trade or profession is the possession of a body of concepts which express the set of relations with which the trade or profession is called upon to deal. The mind of the man adjusts itself automatically to a situation when presented. By one of its salient features he identifies the situation at hand and classifies it against his stock of concepts. It is as if a man were feeling his way about a dark room and stumbled across a familiar piece of furniture; he would then instantly know what part of the room he was in, and would go with certainty to any point which he chose, because, with his mental concept of the room, he could arrange all its parts around the single point which he was able to recognize and identify. This would imply that he had at some previous time explored that room in order to form that mental concept of it. A railroad yardmaster sent down to a strange yard inquires where are the main-line connections, the incoming tracks, the classification

tracks, the outgoing tracks, the house, the team and private tracks, and he identifies each part against a previous yard from which he may just have come, or against his general notion of a yard evolved out of his experience in many yards; and at once he is at home.

The whole value of a man's stock of concepts depends upon their *availability*. Availability means not only the power to describe such concepts, but that intimate sense-relation with them which enables the man instantly to refer the situation to the concept which explains it, and, thoroughly adjusting himself, to get what he wants. He is a section foreman repairing tracks. He senses the drainage conditions of the roadbed; his eye unconsciously picks up the defective ties, the low points in the track, and in his desire to make good track, almost without conscious mental effort, he is directed to the first thing necessary to produce the result desired. With long practice he has acquired the concept of a tie which is a standard tie; of a track which is even up to standard requirements; of a roadbed that is dry and properly drained, as dictated by operating necessities; of the relation of the work proposed to any particular season and its probable weather and run of business. He has the habit of precautionary reference to time-tables in all that he does, a quick ear to detect approaching trains, an instinctive sense of a fair day's work, hour in and hour out. If he were an engineer and came to his knowledge in the way that implies, these different concepts would largely have been described to him by words and diagrams in the class room and illustrated on inspection tours or in the laboratory, and because of his thoroughly trained mind he would be enabled to store up these concepts in well-indexed order so that they would be sharply defined and instantly available.

It is easily seen that an overstock of concepts could clog and bewilder the faculties and, as a consequence, dull the ardor of attack and the certainty and precision with which the man directs his powers. He would be delayed in groping for that particular concept that applied to the situation, and then he would apply it but feebly.

It is therefore vitally important that these concepts be available instantly in response to the external stimuli which each situation affords. If the concept comes to the worker directly, as a medium to an object immediately sought and greatly to be desired, then this concept, as it were, is wrought into his nature, and his action in the use of it is largely automatic.

RAILROAD ORGANIZATION, AND EDUCATION.

It is to be noted that the railroad was the first industry in point of time to assemble great bodies of men highly organized in grades as well as kinds of service. From the first, a democratic quality has pervaded the elaborate industrial caste of its organization. In spirit always, and much of the time in letter, these grades of service are filled by promotion from below—the higher grades are primarily distinguished from the lower ones by the higher order of skill and ability which they imply. Each grade of service offers in part the preparation for the next grade above, and the notion of *preparation* for a higher position, as an inseparable feature of all current work, has come, in this way, to be the fundamental and distinguishing characteristic running throughout the entire service. Every young man in the railroad's employ, however humble his position, values it partly in terms of the money which he is able to earn and partly in the opportunity for experience that shall make him eligible for greater earning power later on. The more "practical" the man may be, the more diligently he avails himself of the opportunities for experience especially if he be a staff employee. No university offers such possibilities for acquiring fitness as a railroad when properly organized, nor may any university have so large and aggressive a body of learners.

Railroad administration is a system of defined discretion. Those in each rank of the organization are intrusted with a certain scope of power—they sum up and deliver the results of their work to those next in authority, to whom an additional range of authority is allowed. By this process of elimination, details are successively condensed, and pass up to the higher officers, in whose hands they take the form of general facts that shall serve as bases for evolving general policies. The larger and more difficult questions of policy, being evolved from this detail, require familiar knowledge of it for their intelligent solution. The switch crew is busy riding cuts of listed cars over the hump to make up designated individual trains; the yardmaster is absorbed with the problem of getting the greatest total number of cars out of his yard in the least time with the least number of switch crews and with the proper adjustment to main-line conditions. He must, therefore, know what are the working conditions of the switch crews as affected by bad rail, fog, snow, temperature, bad loading, run of loads and empties, manifest and slow freight, air cars and "jacks," main-line irregularities, etc.

The trainmaster's problem is to keep his yards clean, his train movement even and prompt, his power balanced, his engines under rated load, his accidents at the minimum. Therefore, to a working knowledge of the yard conditions he must add familiarity with running conditions on the road and at the dispatcher's key. He should know,

from actual first-hand familiarity with the facts, the effect on pulling trains of weather, bad rail, poor coal, bad steaming, defective air-brakes, bad track. To keep his overtime in check he must be able to criticise dispatcher's train sheets.

The superintendent keeps the daily operations before him by "situation reports." His problem is to make a showing each month in his tons per engine mile, overtime, fuel costs, delayed time, accident reports, etc. To distinguish good work from bad, valid excuses from invalid, he must have familiarity with detail conditions of all the work done under him. He must know the needs of his division in power, coaches, freight-car supply, passing tracks, third tracks, curve elimination, grade reductions, added yard facilities, interlocking protection, added water stations, time-table adjustments, interchange arrangements with connections, etc. The knowledge of working conditions that makes his recommendations reliable is generalized from the multifarious details of daily routine with which all his different subordinates are engrossed. The really effective administration has its finger on the whole organization at every part, constantly testing its efficiency; this is only possible when the superior officer understands thoroughly and practically the conditions of the work which he supervises.

Hence it is that the lower orders of work furnish a very large part of the experience and skill required in the higher places. An accurate knowledge of detail in some one department gives the employee a secure footing from which, and in the terms of which, he can widen his knowledge to include that general notion of other departments requisite in the higher offices where the lines of authority converge.

A man who has been a yardmaster is excellently qualified to be a trainmaster. He knows the conditions of moving freight and of handling train men; he has the habit of meeting emergencies with coolness and dispatch. A station agent at a competitive point is excellently qualified for higher service in the traffic department; he knows the requirements of shippers, the lines of competitive movement; he knows the technique of quoting rates and receiving, billing, and delivering freight. He knows also the physical conditions of certain classes of freight and the method of adjustment of claims. A chief clerk is admirably trained in the requirements of his chief's office. A fireman comes naturally from an engine wiper, and an engineer from a fireman. A telegrapher who has been handling train orders moves up naturally to the dispatcher's key.

This long course of movement is more particularly along lines of administrative work. In nonadministrative work it is less true; the engineer does not often go beyond his engine nor the conductor beyond his run; the section foreman does not often become a division engineer nor the mechanic a master mechanic. This is because, while

fitness for these places, as we have seen, does include a part of the fitness required beyond, it includes only a part, and is deficient in some essential part. Men in these places reach their full earning power comparatively early. That is, some of the places are filled through a long course of preparation and promotion, others are quickly reached and must be filled by those of mature years because of the physical requirements.

It may be that a subsequent era of railroading will modify this situation and find it to the advantage of railroads to develop more general ability in their officials and employees by offering, to the specially trained, the opportunity to widen their range, and by holding the course of movement less rigid within departmental lines.

But with all its tempting possibilities to the educator, the railroad is primarily an operating plant. However great its potentialities as an educational institution, they are only secondary and incidental to the first purpose of the road, namely, to earn money. Throughout the whole organization two forces to a degree are operative. On the one hand the influence of expediency and economy in getting the immediate routine work done as quickly and cheaply as possible, and on the other hand the instinct of the ambitious to learn, joined with the inclination of the railroad to turn to account the educational opportunities which lie within its scope. For both the railroad and the employee the use of educational opportunities is a matter of deferred return, which only a greater foresight than that of the day-to-day manager and worker enables them to justify.

The manager is constantly perfecting his machine for greater and greater efficiency by eliminating the waste and awkward effort. This elimination of waste and awkward effort is effected by fitting materials and men more exactly to their uses—in a word, by "specialization." The efficiency of the machine increases with further and further subdivision of the functions of every part. By modern administrative methods these highly specialized assignments of work can be reduced to scale of exact units, which serve as the basis of piecework wages, either "flat" or "premium." The finality and exactness of these measures applied to the work of human beings is startling. The entire work of every man in a body of many thousands scattered up and down a great system can be expressed in single coefficients. Likewise the efficiency of groups, shops, departments, and of the entire body can be summarized progressively in single coefficients for each, and plotted over a series of months in a curve. Perhaps the most notable example of such work is on the Atchison, Topeka and Santa Fe Railway.

Relying on his system, which in an intricate organization absolutely identifies each man's contribution by equitable measures, the piecework enthusiast sees indefinite possibilities in specialization.

The old trade areas of skill have been broken down, and now the minute subdivisions of skill remaining are threatened to be succeeded by mere deftness—sensitiveness of eye, ear, and touch, and precision of dexterity. Frequently the boy six months at a tool by his nimbler organization outdoes the experienced employee. Should the piecework engineer be correct, elaborate apprenticeships or education of any kind would be superfluous. In fact, the apprenticeship plan carried out so elaborately on the New York Central lines does not seem to be considered practicable at the American Locomotive Company's shops, where much the same work is done, but on a more specialized basis. It is a question of the *reserve of ability* that is required for each day's output. This reserve of ability is to provide for irregularities, to coordinate the work in a particular assignment with the other factors of the joint product, and in unnoted ways to give continuity and complete reliability. It makes for that faculty in the worker called "responsibility," which in the foreman is the main function for which he is paid. It gives to the units of output quality which in unmeasured ways reaches through to the final point of efficiency in the day's output. The intricately social character and also the continuing character of the work which is measured in units of daily output must not be lost sight of. There should be a reserve of ability at every point throughout the organization, and this calls for more general training than the extreme piecework man would concede.

There is a point, which advances as the scope of the railroad's operations widens, up to which it is good business for the railroad to use its educational machinery, even at the expense of the work immediately at hand. It is the eagerness of the division master mechanic to get as much work as possible out of his men at the least cost, so as to make a day-to-day or month-to-month showing, which renders him careless of apprentices, whose value to his division will only be realized some years hence, when he may have gone elsewhere. To guard against such false economy for the road, superintendents of apprentices are sometimes appointed to take over the care of apprentices. In the absence of such supervision fixed regulations are devised to meet, so far as possible, the same exigency.

A fuller and more intelligent recognition by railroad managers and directors of the intricate play of social and educational forces that lie between the debit and credit side of the railroad income account is much to be desired. In proportion as their operations multiply the area of indirect effects widens.

FITNESS TO BE ACQUIRED.

The particular equipment that shall constitute the fitness of a man for any given assignment or sphere of work can not be reduced to certainty, like the design of a jig or tool. If we would describe this fitness in abstract qualities, the terms are too indefinite and unreliable. If we go to the other extreme, and describe it in certain acquired habits of procedure, the terms are too narrow. If we take the middle ground, and describe the fitness as the mental acquisition of a selected group of facts and methods, we shall still be as wide of the mark. But if to this we add on the one side careful estimates of such qualities as alertness, thoroughness, resourcefulness, memory, power of analysis and synthesis, etc., and on the other hand acquired habits of dexterity and precision in some one or more of the details of the assignment, we may sketch out very rudely the fitness required in the assignment. The Carnegie Technical Schools at Pittsburg lay special emphasis on a personal interview by the teacher before the student enters. At this interview the teacher undertakes to identify the general qualities which indicate certain broad lines of adaptability, and the student's course of preparation for life fitness is advised accordingly. At the one extreme are the men with tendency to abstract thought—speculative, inventive. At the other extreme are the men of action—prompt, precise, impatient of whatever is indefinite and uncertain. Beginning with the native qualities best applying to a particular career, the Carnegie School aims to develop these by exercise, and by instruction equips the student with familiar knowledge of the body of facts and methods in his trade or profession. The theoretical knowledge of these is carried down to the stage of a tool sense by actual shopwork.

The railroad service embraces a wider range of talent than any other industry. The kinds of work done are so diverse as to make any comprehensive standard of fitness impossible. The fitness required must therefore be investigated by classes of work. No two definitions of the fitness for a particular assignment will agree, so that in essaying to specify the fitness in certain places in the service the educator should aim to illustrate, rather than to lay down with any finality, the conditions governing.

The several departments of the railroad furnish each a different outlook on the road as a whole. Throughout all the departments the principle of gradation of service applies. Often there is more in common among the methods and routine of the same grade of service in different departments than there is in different grades in the same department. Thus, a stenographer with only a little adjustment could move from the superintendent's office to the engineer's office, or the pay-roll clerk from the shop to the transportation department.

The question is frequently asked, Is there a railroad type? Does the railroad-shop man differ essentially from the regular mechanic? Is the section laborer more nearly related to the locomotive engineer than to the farmer along the right of way? Has the auditor's clerk more in common with the engine wiper than with his brother bookkeeper in general employ? These questions can only be answered by opinions which are not susceptible of specific proof. But they are legitimate and practical questions for the educator to ask. Those who have employed both railroad men and those not in the railroad employ distinctly claim there is a difference. The difference seems to be in the more ready acquiescence in the impersonal relation of superior and subordinate, in the acceptance of "orders" or "instructions" and definition of authority, in understanding the abstract sense of "on duty," in facing danger and emergency with resolution, and in adjustment to the administrative machinery of vouchers, pay rolls, requisitions, reports, specifications, and general policy. These qualifications are rather the product of experience under actual working conditions and are not to be imparted by instruction. The educator can only prepare the mind of the young man in this respect by supplying him with the lore of his profession, the story of its brilliant careers, and speculative description of its spirit.

In conclusion, railroad organization is in theory an effort to classify the men of a working body according to kinds and degrees of skill so as to produce the greatest aggregate efficiency. The skill that produces this efficiency is in constant request, and, within limits, every new increment of skill in a body of railroad employees means a new increment of efficiency or earning power of the railroad as a whole.

To a greater or less degree, and at all times to a degree never yet fully tested, this skill which makes for efficiency can be acquired by preparation. In the railroad service itself this theory that skill is largely a thing acquired prevails and is worked out in its system of promotion—a system whereby each gradation of service is held in part to be the preparation to the next higher. As preparation of any kind is the process of passing from awkward to efficient effort, time and resources devoted to such preparation are part of any well-planned layout of work. Some preparation is indispensably present in all orderly effort; in shop practice it is the making of the jig or tool.

In the same way as preparation is an inseparable part of the orderly effort that makes for efficiency, so orderly preparation is but a further stage in the enhancement of efficiency. Skill or fitness for railroad service we would seek to acquire by definite preparation. Such skill is the possession of a body of concepts that set out in causal order the situations with which the railroad man must deal. The

practical value of such concepts lies in their instant availability. If the man comes at them by word definition and description alone he is in danger of not so absorbing them into his organization as to be able to turn them quickly into action, and therefore make them practical. If, on the other hand, he has acquired them in the drill of actual practical experience, they are instantly and unconsciously ready at hand for his practical uses, but are liable to be expressed in narrow and accidental terms of his personal experience, and therefore do not give to him as wide a range of adjustment in meeting unusual combinations and identifying them as phases by reference to general principles. In this way is the so-called theoretical set over against the so-called practical, and in individual cases the honors fall to the one side or to the other according as special personalities or local circumstances may be the prevailing factors.

As to the area of skill which the preparation is designed to compass, we would repeat that the tendency to specialization is offset by a requirement of quality in the work which calls for a reserve of ability above the instant current demand.

II. EFFICIENCY AND COMPENSATION.

The conception of the working force of a railroad as an aggregate of individual workers of different kinds and degrees of skill arranged in the exact order of their efficiency, each producing his daily output and receiving his direct daily wage therefor, is greatly modified in practice. Any scheme of education for railroad employees must take this into view.

The possibilities of education for railroad service have been discussed for many years, but until very recently the direct practical relation between the railroad and educational agencies has been disappointingly small. The peculiar reason for this failure lies, perhaps, in the fact that compensation, as we have indicated, is not always directly based on present fitness. This is primarily due to the fact that the product of the railroad workers is to an unusual degree a joint product; function is highly differentiated. Inevitably, under such conditions, social forces have large play in effecting a distribution of the joint product, or in setting up the working conditions of each contributor. The several grades of employ are primarily grades of efficiency, but they have also come to serve as a device organization, to give it coherence. In this use they carry in part the same difference of earning power and working conditions which superiority of skill alone would command. In greater or less degree they also carry authority, or mere precedence and privilege without authority; but,

however adjusted, through these grades and in this way is effected the administrative control of the working body. Thus is formed into ranks of tens and hundreds, as it were, an original democracy of fitness, with the result, as we have already asserted, that compensation is not exactly proportioned to present fitness.

Because of the influence of this system upon the education of railroad men it may be worth while, in seeking an explanation of such apparent inequity, to inquire more carefully into the social nature of railroad employment. Railroad employees come with the purpose of remaining with the company; they "enter the service." Their compensation at any instant is more or less averaged out of their estimated usefulness over a period longer than a week or a month. To this end they are put into ranks defined by certain group conditions as to general skill and scope of immediate opportunity. A special case in point is the wages paid to apprentices, which are made to advance arbitrarily 2 cents per hour each year of the apprenticeship. The same road that pays an ordinary apprentice 10 cents an hour will pay a special apprentice 14 cents an hour. This does not represent a difference of present efficiency, but it is a necessary adjustment to attract the special apprentice, who is older and who must be self-supporting at once. The railroad must be justified by the expectation of a return at some later period. Throughout a large part of the working force it is probably true that the services of the regular employee could, for a limited period, be performed by others at less wages, and the difference to the company might hardly be noticeable. The regular employee's wages may for a time be higher or for a time be lower than a current competition would determine, but over the entire usual career of the employee they come to bear, in intent, a fair relation to the work done.

THE SENIORITY WAGE PRINCIPLE.

Thus the play of social forces is here seen affecting, in large measure, the apportionment of the reward. To explain this a little more fully: The highest efficiency of any individual is so dependent on the cooperative efficiency of his fellow-workers that unless they yield this cooperation in full measure the individual's work loses most of its value. Furthermore, until very recently there have been wanting any reliable systems for measuring individual efficiency. In such team work seniority is everywhere the primitive basis of just apportionment of recognition and privilege, carrying with it, as it does, a crude approximation of relative fitness in those indefinite acquirements called "experience." In different localities and different groups the basis of social deference will be, variously, social position, nationality, education, moral excellence, personal prowess, standing in labor unions, or political strength, to each of which in turn the

scheme of organization comes to make some measure of concession. But these are phases only. Country wide, the general basis of distinction among the members of a working group is seniority. To seniority in the group is accorded precedence in tenure and also in compensation. The amount of such preference, for lack of a better term, we will call the seniority wage.

This seniority wage, as we have seen, may take the form of more permanent employment, and superior working conditions, or of more actual wages, or it may manifest itself under guise of designated positions carrying certain supervisory functions. But in some form or other it is almost always present. The seniority wage fund may be appropriated from the general wage fund of the working body, or it may come from the profits of the company, representing, over a long period of time, the share which labor enjoys, with capital, of the unearned increment of the business. In the case of the higher administrative positions on the railroad, and in varying degree through the staff positions, it would seem to be derived from the latter source. In the case of those roads having pensions some part of the entire amount paid in wages would also seem to be derived from this source. On these roads, at the last of the man's career, the seniority wage is set out definitely in a separate amount and called a pension, which he draws after his services have ceased altogether. It would be absurd to suppose that such allowance begins—in the form of a pension—instantly the age limit is reached. It is more to the point to say that similar payment has been included in the amount paid as wages since the zenith of efficiency was passed. Practice such as this grows under the steady pressure of deeply underlying conditions about which there may be little thought and less attempt at definition.

The seniority wage, in addition to the efficiency wage under current competitive conditions, is based on good business principles provided it is within reason, and rests on some qualification that makes for the joint efficiency of the group where it has play. If taken from profits it causes the least confusion. If drawn from the wages of juniors it must not subtract so much from the reward of current individual efficiency as to discourage this efficiency, but it should be large enough to offer substantial inducement for continuous service and a spirit of cordial loyalty throughout the entire working body.

Such allowance, because indefinite, and not based on a stated principle, can be very demoralizing in a service. If at any time it is in excess of the amount necessary to attract the grade of men which it is intended to secure, or if based on any factor not tending to social efficiency, it ceases to be justified by the large business principles on which it should rest and falls to the level of pure favoritism. It would be better for the interest of the educator—and for the road

generally—if the practice were clearly recognized and defined so that the payment could be calculated with some precision, and separated from the current efficiency wage. The practice, indeed, is of vital interest in discussing any educational programme, because the great incentive to preparation by vocational education of any kind must always be the monetary rewards and social recognition held out in the profession where the education is to apply. Hence the educator is peculiarly involved in any abuse of the seniority wage principle, and to the extent that his work is limited the efficiency of the entire working body is affected.

That the wages or salary paid does include some allowance that comes under this description is universally evidenced by the importance given to seniority in an organization. Those who in any degree enjoy the advantage of seniority over their fellow-employees guard it most sacredly. They very readily accept the usual explanation that it is the difference of reward due to their superior ability or "experience." It is this that confounds the educator, and at the same time creates a spirit that tends to defeat his efforts to improve the facilities for acquiring experience and superior fitness. The favorite words "theoretical" and "practical" are made to do yeoman duty in defending a wage preference on the grounds of a superior ability which does not necessarily exist, when in reality such discrimination may be amply vindicated on other and far surer grounds.

The whole matter comes into sharp definition when we examine the objections which organized labor has at times raised to radical changes in the methods of training apprentices. The superior efficiency of the educator's methods can greatly reduce the period of apprenticeship. If, for instance, it might be that instead of the full five years hitherto required, the period, by the use of superior methods, could be shortened to three years, it is obvious that the barrier between the journeyman and unskilled labor would also be reduced from five to three years. This would temporarily increase the number of apprentices graduating. The objection raised would be the natural one, namely, that the standard of skill would be lowered by such an innovation, and this might in part be true. But the real objection would be that the competitive earning power of the present journeymen in the trade would be jeopardized. It would be the same effect as the disorganization following on the introduction of a labor-saving machine. The labor saving in this case would be in the processes of education. Society as a whole would be the gainer, but the burden would fall entirely upon the journeymen now in the trade, and this burden they would have to bear until the adjustment was accomplished. A railroad can, and frequently does, ease over such a point of adjustment by absorbing some of the shock of such changes

by the device of seniority. If the saving is large and promises to be permanent it can fairly afford to do this on sound business principles.

Seniority has always been looked upon as being the seniority of the individual with reference to the others in his working group. Inasmuch as this group is purely accidental and arbitrary, seniority is purely a relative term. A clerk at a local station advances from desk to desk in the order of seniority at that station, whereas at the next station on the line his contemporary makes a much more rapid succession because, by contingencies entirely beyond his control, the deaths and resignations ahead of him are greater. But both clerks, at the last, may be outdistanced by the staff clerk at the division office, who is much younger, but advances so much more rapidly because, by mere chance, in the office in which his desk is placed the desk next to his is that of an official instead of a mere clerk. By the thoughtless sequence of mere propinquity he succeeds to this next desk. Again—carrying the illustration further—on one division, by peculiar fatality, the rule seems to be that "few die and none resign," and therefore the employees here are practically fixtures for most of their days. On an adjoining division, possibly some two or three officials have left for other fields, and later have drawn heavily for good material on the staffs which they left behind. Under these conditions promotion on this division is very rapid, but the rule that all promotions must be within the lines of a division absolutely debars the employees of the first division from the opportunities offered, while at the same time the second division is the loser by the amount of superior skill and experience on which it is not permitted to draw. The writer has known college graduates looking eagerly to the opportunities of a railroad career, but unable to enter the service at their more advanced age on less than a self-supporting wage—one which the office boy living at home could accept. The fallacy lay, not necessarily in the seniority idea, but in the severe limitation of it to the particular local group where the employment was had, excluding from view the time and serious effort spent in school and college toward securing efficiency. So top-heavy and awkward has the seniority-wage principle become at times in wrong application that, instead of making for, it has inclined to defeat the efficiency of the working force to which it was intended to be an advantage. For instance, when Mr. Barnard, of the Baltimore and Ohio Railroad, in the early eighties, undertook to establish a school and a comprehensive system of apprenticeship for railroad employ, he found over the line medieval conditions of prejudice, distrust, and bigotry. Each shop force represented a various assortment of local standards of practice and skill which it guarded, as from seizure, with the jealousy of a medieval guild. Instead of the intelligent rivalry among divisions aiming to perfect general standards of effi-

ciency, there was a vast aggregate of talent, money, and time spent in the lost motion of duplicate work, conflicting methods, neglected results, and indecent, jealous wrangling.

The writer recalls the case of a general superintendent's office in need of an office boy. Advertisement brought a reply from an eager college graduate, but the appointment being left in the hands of a subordinate of limited capacity, he at once distrusted the applicant with such education—who would be in too close succession to himself—and at considerable inconvenience to the office deferred the appointment until he could find an applicant of less intelligence. Meanwhile the stockholders paid the bill. And again, the writer recalls the advice given by the railroad comptroller, his employer, to a college man who had got into the service, urging him—unless he had particular backing—to leave at his earliest opportunity for more promising fields. The inevitable effect of such advice was the disillusionment of an eager employee, who, however, had acquired enough of the practice before leaving, to adapt a system later, when in private employ, that has since revolutionized much of the railroad accounting technique of the country. But this was lost to the railroad which had first employed him. It is practice such as this which has such significance to the educator. The late W. H. Baldwin, president of the Long Island Railroad, said: "The problem of educating men for railroad employ is really a problem of how to inject educated men into railroad employ."

RESERVE OF ABILITY: ITS BEARING ON INDUSTRIAL ORGANIZATION.

Seniority implies experience, and is therefore made to serve as a rough index to fitness. This fitness is seen to be twofold—on the one hand it is the fitness for current, routine requirements, and on the other hand it is a reserve of ability for the extraordinary occasions where routine demands are exceeded. With the division of labor, work is every day becoming more highly specialized, and the most efficient shop, generally speaking, is that in which the division of labor is carried furthest, and where the routine is so far perfected that the extraordinary is very largely eliminated. The area of skill which was formerly called a trade has been cut up into minute subdivisions, some of which can be learned in a very short time, and do not require the maturity and breadth of view in the operator which the trade as a whole required. A shop or a department under a highly organized management has become a machine whose parts are intensely specialized, individual machines, composed partly of the man and partly of the tool to which he is assigned. The work itself is reduced to a lot of minute and almost ultimate units which shall serve as the scale of the worker's efficiency, and also enable the manager to know his own costs in advance, to unite the elements of

this cost into varying combinations at will, and thus schedule out his work with the precision of an industrial chemist. In the advance of the arts the latest special machinery of to-day will be scrapped to-morrow, and with the machine goes its operator—into the same scrap pile. At this stage are two opposing interests: On the one hand, that of the manager to produce the greatest possible efficiency by the highest possible type of machinery and skill; on the other hand, that of the worker who seeks to preserve his individuality and to have wider usefulness than that attaching to the particular machine to which he is assigned. With the worker is aligned the educator, who undertakes with the latest and best equipment of pedagogical method to fit the worker for his career. Exactly how much of wider skill than the routine of a particular assignment is demanded by the manager for efficiency's sake depends upon his estimate of the need of that reserve of ability that enables the worker to meet with address the accidents and irregularities of his own assignment, to adjust himself intelligently, so far as he has discretion, to the working pace of the other parts of the organization, and finally to evolve into concrete form the suggestions of improvement worked out of present practice.

With the area of skill so minutely subdivided the worker is no longer protected, as formerly, from unskilled labor by the barrier of years of preparation which the acquisition of a full trade imposes. If he is in some other way to receive the same protection that he formerly did by virtue of his trade monopoly, and if he is also to be saved from the scrap heap in the same way as the wider area of his trade preserved him from the chances of some minute applications of it, some of his objections to the present tendency, so far as it affects himself, are modified. It is inconceivable that the present tendency can go much further without the emergence of some such principle as this.

Such considerations aside, the problem shifts to the question of what is the area of that reserve of ability which shall have effective value to offset the time and effort to acquire it. At present there is much confusion of testimony in this regard, but the writer leans to the conclusion that the honors are with those who would give the workman a broad foundation on which to stand.

AN IMPROVED PENSION SYSTEM.

Among other sociological devices to enhance the quality of the service and so increase the railroad's efficiency, a pension system is of large importance. It separates the superannuated from the body of efficient workers without hardship, and so gives free play to current efficiency. There have been pension systems in force for many years. With the large good accomplished, many have the defect of tying up a man absolutely to the service of the particular road where

he may be placed, so that the sense of full freedom as a factor to his most efficient service is impaired. The Boston and Maine Railroad is just inaugurating a plan which aims to overcome this defect. The fact that the working plan under which the trust is undertaken was enacted as a law by the legislature emphasizes in an especial way the public character of all undertakings by railroads in this direction. The key to the plan is furnished by the expression of Mr. Louis D. Brandeis—"obligatory contributions secured by democratic methods." The plan is fully described by the New York Independent of June 3, 1909:

1. The system is cooperative in contributions. The pensions to be provided will be supplied by equal contributions from employer and employees, subject only to the clause that the employer will make up any deficiency so that the minimum annual payment shall be not less than $200. To meet the hardships incident to those already advanced in years and service, the company undertakes to make an additional contribution, the amount of which is being left to its discretion. With a view to encouraging a reasonably large old-age income, provision is made by which regular pensions may be supplemented by annuities to be purchased by the men voluntarily through current contributions from income.

2. The system is cooperative in management. The rules governing the system are to be made by the board of trustees in which the railroad and the employees have equal representation.

3. The system is cooperative also in this: That its establishment depends upon its being adopted by vote of both the railroad and the employees, a vote of two-thirds of the employees voting thereon being required for its adoption.

4. The system creates legal rights. A great defect in systems established by railroads and other large corporations has been that they create a body of dependents, and in many instances that doubtless was the main purpose. Under such systems the pension, not being a right, proves often to have been delusive, and perhaps more frequently is used to limit the freedom of the worker. Under the Boston and Maine bill the employee acquires a legal right to the pension. If he ceased to be an employee of the company he loses the pension proper, but he has paid to him an amount equal to at least the amount of his contributions.

5. The "elective obligatory" clause is an entirely new feature in pension legislation. Under this clause the system, when established by the vote of the railroad and the employees, becomes obligatory upon all persons thereafter entering the employ of the railroad, and upon all persons in the employ of the railroad at the time the system was established, except such persons who both voted against the adoption of the system and recorded within three months thereafter their objections thereto. By virtue of this provision it is expected that the system will become operative, upon its establishment, upon practically all the 27,000 employees of the system, and that thereafter the contributions to the fund will become practically automatic through the deductions from wages. By this means are secured obligatory contributions by democratic methods.

6. The pension funds are exempt from taxation, and the right to the pension is made an inalienable right. It involves prohibition of loss of the bare means of subsistence either through legal processes or voluntary act, just as much as loss of liberty through selling oneself into servitude.

7. The supervision of the pension system is placed under the same state supervision as applies to ordinary insurance, or savings-bank insurance and pension system. In the case of this railroad, provision is made under government supervision for a separate savings institution, carefully guarded even to the point of having both the insur-

ance commissioner and the state actuary join in supervision with a view to securing the greatest possible safety.

This bill was enacted upon petition of the employees of the railroad, but had throughout the sympathetic cooperation of the railroad officials, which was rather an extraordinary example of enlightened action on the part of a great corporation.

This act is an important step, for we believe Massachusetts will follow it with an extension of the cooperative system to cover accident insurance and invalid insurance, and will develop out of this bill a general law under which other public service and private corporations may put into operation a cooperative old-age pension system.

In conclusion, the bewildering interior of a railroad organization, honeycombed with prescriptive rights, resting on all manner of pretenses, is giving way to a simpler and more rational scheme. On the one hand, there is recognition, more or less indefinite, of what we have seen fit to call the seniority wage—which is that concession to the individual worker based on his general credentials of fitness, by persistence, experience, and loyalty—qualifications which tend to give coherence to the aggregate of individuals, a coherence which makes them a working body. But if in the making of this seniority rating the reference is only to a local and accidental group, and credentials can not be carried from other groups or forms of work—such as the schools or other railroads offer—the scheme is illiberal, faulty, and tends to the inefficiency which it sets out to avoid. On the other hand, the introduction of the piecework systems and efficiency systems, when conducted on right principles of fair dealing, are a move in the direction of computing the current efficiency wage on an honest and equitable basis, namely, upon the basis of actual individual productivity. The educator seeks to equip the man with that reserve of ability that shall fit him for the contingencies of a specific assignment, and for quickest adjustment to the progressive requirements of a career by promotion. Under a current efficiency system of pay, whether premium or flat piecework, it is not easy to plot all parts of the work on a scale of absolute units. With the current efficiency units should go also a rating to express the reserve of ability, which can only be estimated by what the man knows of the things that bear directly and indirectly upon his work.

III. EDUCATION *EN MASSE.*

Education is primarily the education of the individual, by himself or in groups, as it may be best accomplished, but to the end that each learner increases his *individual* efficiency and his *individual* wage-earning power directly. Education also includes that form of work which increases the individual's intelligence, and thus increases his efficiency and skill in doing things by formula, without necessarily disturbing his relative earning power directly. The first form is

individual education, the latter, for lack of a better term, we will call "education *en masse*."

Education *en masse* differs from individual education in that it is much cruder, carries a shorter way, is less a matter of intellect, and more of trained skill and moral quality. It takes the form of specific technical instruction and merges by degrees into "welfare work." It is closely allied with "discipline," which deals as much with the problems of arousing and holding the attention alert and active, as with the moral qualities of faithful work and sense of duty.

For instance, the advantage to a railroad of raising the general standard of intelligence, and then of practice, let us say, in firing locomotives or handling freight at stations, is quickly obvious in dollars and cents. But the extension of the work from such specific technical instruction down the scale to mere welfare work shows less directly the money result. Yet they merge into each other by such continuous and imperceptible stages that reference to the principle on which this kind of work rests would not be amiss.

The whole aim of education, as we have said, is to increase the efficiency of the worker. The relations are complex, and the results are necessarily indirect and involved with many incidental products. The increase in the worker's value is twofold. It is an increase (1) in the worker's value to himself, and (2) in his value to the railroad. The increased value to the worker himself is primarily in terms of that ultimate criterion, namely, enhanced self-respect based on enlarged sense of personal efficiency and power, expressing itself in more initiative and enthusiastic effort. This improvement in the quality of his work, of course, accrues to the railroad, and justifies its interest. In order to set up enhanced self-respect and improve the facilities of the worker, the railroad devotes, not improperly, some of its efforts in fields where the first and direct effect is an increase of the worker's value to himself in cash, and in convenience and comfort, but without increase in wages. It therefore turns its machinery over to providing various services at cost, as, for instance, collecting insurance premiums, superannuation funds, school tuition, and union dues through the regular monthly pay roll; or providing at cost bunk houses or lodging houses, libraries, clubrooms, lunches, baths, and entertainment. There is a large range of such services which come under the general head of "welfare work," which is merely a matter of turning over to the employees as consumers the assembly value of the railroad, without cost. These various services, if secured in the ordinary way, would cost the individual employee as consumer a charge representing profits on good will.

Remembering that the whole purpose in all of these efforts is to increase the worker's self-respect and improve his work conditions as a means of increasing his efficiency, it is obvious that the undertaking

is only of value so long as it does do these things. However nice the economy, when it passes beyond this point and tends to cripple the worker's self-reliance, it becomes a menace, and will ultimately show itself in the income account of the railroad. What the worker can accept in this form of service from the railroad without trespassing on his self-respect, will increase with the growth of his intelligence. If these agencies are used as a device to complicate his situation, to confuse and confound him when he would stand upon his rights, they will ultimately redound in some way to the disadvantage of the railroad. They must be removed from all such suspicion.

SOCIOLOGY AND RAILROAD MANAGEMENT.

The sociological side of railroad management has long been neglected, to the great loss of the railroad's earning power. The Railroad Age Gazette of February 19, 1909, commenting editorially on "The unit in railway operation," says:

> We believe that a closer analysis of the real things that are happening along with the "results" that are produced is needed. Among these real things to be taken into view, and which so far have too often been ignored by railway men, are those far-reaching causes and effects that are working out in the personal temperament and efficiency of the men. Railroading to-day, even within the lines of the operating forces themselves, and quite apart from the public questions raised, is a science of sociology, not less, but even more, than it is a science of mechanical and civil and electrical engineering. Lines of organization are frequently drawn across the grain of human nature in absolute disregard of the normal, healthful social forces that can be drafted into the service of the road and made to register their effects in the income account.
>
> Incidental to the doing of anything the manager should remember that there is a by-product, which is the maintenance and betterment of the intelligence and interest and moral qualities of the man who does the work. This is not upon any sentimental grounds, but from the strict requirements of the situation—to make more money. Mr. Rockefeller has said that his great company has built up its wealth from its by-products. Mismanaged railways have lost great aggregates of wealth by ignoring the by-products to be worked out in the constantly enhanced efficiency of their working force. Few realize the potentialities in an aggregate of 25,000, 50,000, or 100,000 men set into natural unit groups within and through which should be the free selectivity play of all the latent forces in an orderly competition making for the enhancement of the net income of the road. In this eager race for "results," railroading is reduced to a mere arithmetic of superficial and frequently transient or local phases of the great underplay of the profoundly philosophical causes and effects. When to this is added the taint of personal favoritism or the obnoxious features of class consciousness, the situation has become hopeless indeed. There is a need in railroading for that large comprehension that unites the present with the future, the immediate cause with the remote effect, through all the slow intricacies of educational, social, and moral agencies. The great railway edifice at last rests upon the man. No complexity of machinery nor ostentation of aggregates can displace the requirement of self-respecting, eager, individual efficiency.

On the so-called "Harriman lines," which for daring and brilliance of management acknowledge no superior, this principle is already embodied as a working factor in the system of organization. A

trained sociologist, Mr. F. G. Athearn, is given charge, under the designation "superintendent of railway clubs." Referring to his department—that of welfare work—he writes:

> The entire work of enhancing, perfecting, and maintaining the fitness of the men for railroad service has its seat in sound business economy. The problem involved is socio-physiological. The mental and physical fitness and ability of men to do things depend primarily on physiology. A man's physical condition, and mental condition, too, are very largely products of his immediate environment. Food, rest, and recreation are the chief factors involved. There is no need, therefore, to obscure the purpose of any welfare work that may be done for the employee by placing it on the basis of either paternalism, philanthropy, or religion. It should be done for the same reason that any other work is done—because it pays. It should be on a give-and-take basis. The parties concerned are then under colors which can not, by any interpretation, be taken as false. Ulterior motives of subjugation and increase of labor without increase in pay can not be suspected.
>
> The employees' clubs on the Southern Pacific, Oregon Short Line, and other Harriman lines are being built up on this plan, and with the view to providing for the immediate physical and social wants of the typical railroad man. It is the purpose to start with the man and boost, and not to reach down and lift.
>
> It has been fortunate, or unfortunate, according to the individual bias, that there already has been worked out and tested by generations of experience the kind of club best suited to the workingman, in fact, with slight modifications, for all classes. The saloon represents this type. It has been the manual laborer's rendezvous and club since time out of mind. The things which have become a part of the saloon are the results of a long trial. It has been a slow growth, modifications coming from time to time to meet the changes of social conditions incident to succeeding generations. In our present frenzied, money-getting stage the saloon, like many other institutions whose primary function was to minister to the social needs of the community, has been commercialized and its original purpose lost sight of. Those things which lie close to the very life of man are played upon and used for selfish and unlawful ends. Except gambling and strong drink, the saloon offers things most desirable for men to have. The atmosphere of social equality, congenial companionship, the sense of freedom from restraint, the feeling of being welcome, cool and restful places in summer and warm rooms in winter, recreative games, toilet facilities which are, as a rule, the best to be found in the town, reading matter, appetizingly cooked food, and even in some cases beds, at a very low cost—these are some of the things which the saloon has that are worth while.
>
> The employees' clubs have been especially designed to embrace the desirable features of the saloon, plus, and thereby not only counteract its evil influences but offer an effective and real substitute. There are no dues or membership fees. (Do you recall many welfare institutions that have not such dues or fees, or saloons that have?) Every man is made perfectly welcome whether he is a tie tamper or a superintendent, just "so long" as he is a railroad man. There is no free list! The men pay for what they use and the service they get. The library and general conveniences are free—that is, they are a part of the inducement for the men to patronize the club, just as are similar conveniences in a saloon. Meals, baths, beds, billiards and pool, cigars and tobacco, soft drinks, candies, etc., are sold to the men at prices sufficient to insure the best of material and service. With its general facilities, the railroad is in a position to give more for the money than could be done otherwise, and owing to the further fact that it receives a return from the men who patronize the club by reason of their better physical fitness and longer average duration of service, it can and does make a contribution toward the support of the clubs. This contribution is indirect, and furthermore is placed on the basis of payment for greater service received. Under this arrange-

ment the men pay prices which are indeed very low—15 cents for a bed, 10 cents for a bath, and 5 cents an hour for billiards or pool. The beds have the best wire springs, hair mattresses, feather pillows, and are made up on the same standard as a Pullman berth. A bather is furnished two towels, soap, and janitor service. Other things are proportionately cheap.

The men, by paying for the commodities, have a feeling of independence, preserve their self-respect; the uncomfortable sensation of being objects of charity and the something-for-nothing idea are abolished. The result is that the men soon come to have a proprietary interest in the institutions and the clubhouses are crowded night and day. The railroad, by assisting in the support, building and maintaining the structures in repair, and doing it avowedly because it is believed to be good business, dispels any semblance of paternalism and makes the clubs a concrete link in the economic scheme of railroading as a whole.

To all this is added the purely educational work, such as lectures, and study classes organized by the secretaries of the clubs. These classes are voluntary and the subjects studied may be anything from elementary arithmetic to analytic mechanics; but, regardless of the subject, one thing always is taught—that is, how to use sources of information.

Over all these activities the railroad maintains constant supervision. The work is carried on through a regularly established department. It has not been delegated to any outside concern, such as the Young Men's Christian Association, for the reason that it is believed that a perfectly rounded and complete business organization requires that it shall itself control those functions which are of primary importance to its success. The care of the employee is such a function.

It can not be shown exactly what the financial returns to the railroad are from these clubs—this human block system—any more than from the automatic block-signal system upon which millions of dollars have been spent. Ledger balances do not show the saving in wrecks and human lives and increased safety for the traveling public because of greater mental alertness, better physical fitness, and added contentment due to good food, proper rest and recreation, and places that add to the joy of living—the grand averages tell the tale.

TECHNICAL INSTRUCTION AND DISCIPLINE.

Technical instruction *en masse* is closely identified with discipline. As an educational method it is instruction brought down to the level of drill—largely mechanical drill. Because so largely of the nature of drill, it should be closely connected with a system of discipline. If it deteriorates to the grade of mere kindergarten work it will do more harm than good. The method of instruction is chiefly by question and answer, and by severely forcing home—by means of consequential penalties—the lesson of every irregularity or infraction of the rules in practice.

This sort of technical instruction is forced on the railroads in drilling the train service in the train rules, and it is administered generally by the chief dispatcher or train master. On roads where the so-called "Brown" system of discipline is in force, the penalty for infraction of the rules is a set of demerits. On other roads it is suspension, leading up to dismissal. The instruction takes its color largely from the severity of the penalties attached to failure. J. O. Fagan, himself a practical railroad signalman, in his book,

Confessions of a Railroad Signalman, declares that the instruction in train rules lacks the sharp disciplinary quality which its importance calls for. The spirit of his testimony is, in part, that there is not nearly as clear an intellectual understanding and familiarity with the rules as there should be on the part of those who move trains, and, moreover, that such intellectual understanding as there may be is not set against the background of an inexorable discipline as summary and terrible as the consequences of violation of the rules may be to the traveling public.

On the Chicago and Alton Railway, this instruction is given over to one man, who is assigned a special car equipped with every kind of facility for oral, ocular, and mechanical demonstration. Its special feature is its stereopticon, which is a great adjunct in driving home to the mind by visual illustration the conditions with which the book of rules deals. The work is made efficient—because it is a matter of harsh business, and not a kindergarten—by reason of the fact that the instructor has the power of suspension, removal, and promotion.

The fault of most of the instruction in train rules on a railroad is that the specialization principle—found to be so efficient a principle in other departments of work—is ignored in this field. The instruction is left to those who are ill fitted, or not fitted at all, by special training, to give it, and who are, besides, overburdened with heavy administrative duties. These are more immediately pressing than the precautionary regulations for the instruction of train men, and the latter are slighted accordingly.

The instructor deals in the accredited fitness to do things, and he should carry that fitness clear through to the point of delivery in actual efficiency according to well-recognized standards. In other words, he should be—as he is on the Chicago and Alton—the disciplinarian as well. He should have the power of official life and death over his men, and then he will have attention—sharp and certain. The indications are that the administrative work on a railroad will come to be separated from the duties of instruction and routine discipline. A train master accepts his freight cars at the terminal from the car inspector as being up to standard; he accepts his engine from the mechanical department when it has passed certain standard tests; he accepts his roadway and his bridges in the same way; also his signals; he accepts his engineers from the company surgeon as being physically fit. Why should he not accept his men as standard men from a department strictly accountable for their equipment according to recognized standards of efficiency? The work done on the Chicago and Alton must in time be extended elsewhere.

Technical instruction and drill of some kind are imposed on railroads, as we have seen, by the very exigencies of the service which

they perform, but instruction in special features of efficiency in respect to other things than obeying train rules, handling train orders, and reading signals is more a matter of individual discretion. The economic value of systematic instruction in many different phases of railroad work is almost incalculable. In all the detail of operation there is a best way, which is or can be reduced to a standard as accurate as the manual of arms of the army. Such best ways of doing things make each a little saving in time, or material, or in wear, or reduce the danger of minor accident. And viewed collectively these minute savings make a mighty total. The loss and damage expense on railroads has crept up in latter years to frightful aggregates. A course of instruction in loading cars, handling freight at stations, in the inspection of packing, and precaution in delivering, as well as in care in shifting in the yard, would go far to reduce this. The Galena Oil Company has largely supplied for years the railroads of the country with lubricating oil. When they began, they forced their way by offering to guarantee that the oil bill of the railroads should not exceed a certain amount per engine mile. This they were justified in doing, partly because of the superiority of their oil, but probably for the most part because they devoted themselves to the systematic instruction of enginemen on the roads where the oil was in use.

Setting up accurate standards of excellence and instructing the service in thorough familiarity with such rules give to the ignorant a safe rule of conduct, to the careless and shiftless a criterion by which they can accurately be judged, and the knowledge of which will at least lend emphasis to their negligence. As traveling auditor, the writer frequently found a high disciplinary value in enforcing detail rules of procedure as a precaution against serious breaches of trust. The effect is not altogether unlike the effect in the army of requiring rifles and buttons and belt buckles to be burnished for inspection. The mind being held to a habit of precision in minor details, the larger situations take care of themselves.

Among the things of this character which are particularly appropriate subjects for specific technical instruction are the following: Firing locomotives, oiling cars and locomotives, train heating, train lighting, filing tariffs and correspondence, loading and unloading and transferring cars, receiving and delivering freight, reporting claims, care of air brakes, handling explosives.

TECHNICAL INSTRUCTION: METHODS AND SUGGESTIONS.

Railroads variously provide for this instruction by circulars and books of instruction, which they follow up by road foremen of engines, transportation inspectors, traveling auditors, route agents, air-brake-instruction cars, etc.

Such efforts in welfare work and technical instruction *en masse*, so far as now undertaken, demonstrate how the railroad has ready to hand a great social machine which it can turn to large account in a campaign of instruction at little cost. Its publicity facilities for focusing the attention of the force at will are unexcelled. It can and does use them to large results in enforcing discipline. It can further invoke the social motive, to assist the instructor and stimulate thought, by grouping its men by class of work, and drawing them together in convention periodically, at not too frequent intervals, for the purpose of taking up various problems of the daily routine. The writer at one time organized the division office clerks over the road into an association, meeting once in three months. The meetings were given something of a holiday character, so that the men were eager to attend. The programme was worked out carefully in advance, and the men came prepared to discuss particular subjects, much work being done between meetings by committee. At the meetings themselves half the time was given over to severely hard work by discussion, instruction, demonstration, and exchange of experiences. For the purposes of general discussion the greatest freedom of expression was not only encouraged but insisted upon. With perfect good faith and loyalty, yet without any restrictions, no office, nor official, nor official act which came before the men was excepted from drastic criticism and analysis so far as these were within their powers to make. The result was, first, some excellent specific work, along lines evolved from the intelligence of those who could contribute most to such intensive study, and, second, enormous mental stimulation, which gave to every man a new interest in his work as he saw its wider bearings and the reasons for it. Out of these conferences came suggestions which put superior officers on their mettle. It is surprising, when all the intelligence of a particular department is drawn into full action, how large is the gain—a gain which railroads lose when the department's powers, individual and collective, are only allowed expression through the channels of a rigid system of official precedence. In broad terms, the work here indicated was a kind of education, and one which the railroads would find it profitable to pursue.

Wherever men come together there is evolved a social estimate. Like the wasted water powers of the country, this enormous potentiality for social results is frittered away on the railroads by disuse or abuse. It is sometimes aggrandized to the personal benefit of individual railroad officials, to the distortion of proportions that make for efficiency, and so to the ultimate loss of the railroad's income account. Again, it is used by the labor agitator to push or support propaganda, or it loses itself in a lot of cross currents and

eddies about accidental personalities or trivial issues. If skillfully directed by a systematic publicity of the things that make for social efficiency, its educational and corrective power is enormous. The Union Pacific Railroad, for instance, systematically turns its accidents to educational account. This it does by making each considerable accident a matter of public study, and by publishing the findings of a mixed court of railroad employees, officials, and prominent citizens. In extraordinary cases an expert is sent at once to make a special study of the accident, solely with a view to digging out and reporting the lesson for the future which it offers.

A railroad gazette that gets into the homes of the employees, when wisely conducted, is a large factor for efficiency. It chronicles special personal achievements, gives railroad reports, discusses the purport of orders and prescribed methods and standards of operation. Its "stove talk" or "roundhouse chat" gives personal interest to its columns. The "Erie," the "Rock Island," the "Frisco," and the "Atchison" each has such a paper.

A very large part of the educational possibilities of a railroad are supplied by the interplay of legitimate local rivalries and of group loyalties. Ill-designed organization loses much of these possibilities to the railroad. The fundamental axiom of lodging responsibility exactly against authority, and of setting out the organization as far as possible in groups having the largest autonomy consistent with reasonable coordination, is given scant consideration. The tendency to concentration, however, has now apparently spent itself, and the tendency to decentralization has set in.

Again, the railroads lose large educational opportunities because they do not interchange their employees more freely between departments and between different railroads, and so get the enhanced efficiency that comes from such mental stimulus and enlarged view.

IV. BEARING THE EXPENSE OF SPECIALIZED RAILROAD EDUCATION.

Railroad education of any kind is costly, both in time and money. It is an associate undertaking requiring its own plant, agencies, professional methods and standards, and also calling for recognition and place in the policies of the railroads where it is to apply. The burden of it must be borne by those who enjoy the results that flow from it. Such are the community, the railroad business as a whole, the individual railroad, the individual himself. According to the degree of individualization prevailing, these parties will share variously in the results.

We have set out to a class by itself, under the arbitrary designation of "education *en masse*," those forms of education which apply to groups of men already in railroad employ. Such education is not dissimilar in effect to general orders designed to standardize the service in some particular. It is accepted by the men as an incident of employ or a fixed part of their duties; it is paid for by the railroad as a part of its administrative expense; its results are directly reflected in the betterment of the service, and have a more or less direct money equivalent. The rate of pay is not thereby directly affected, because the relative efficiency of the individuals within a group is not materially disturbed.

In contrast with this is severely "individual education." By this we would embrace the education which it is entirely optional with the individual to acquire or not to acquire, and which, furthermore, because acquired individually, very directly determines the student's relative efficiency and personal earning power. Entire freedom of contract and the aversion to binding employment contracts of any kind put the whole matter on a severely voluntary basis. Theoretically, when the individual is specially educated, he is at once raised to a higher earning power; the railroad must at once pay the increased value of his services or lose them to the competitive road which will pay this price; or the individual may even leave the railroad business altogether. The old indenture of apprenticeship, which enabled the master to hold at law his apprentice until the apprentice reimbursed him with his advanced efficiency at low wages, is a thing of the past. The form of contract, it is true, does irregularly survive, but its legal enforcement is also a thing of the past; the community, the railroad business, or the individual railroad to-day must rely on inherent tendencies and general conditions of labor for return of outlays devoted to railroad education. The results are indirect, but they are not for this reason any the less secure. In fact, because indirect, and because resting on inherent tendencies, they probably are more secure than they could possibly be if they depended on formally evolved, binding agreements.

INDIVIDUAL EDUCATION AND THE COMMUNITY.

With the development of industrial and commercial society the area of indirect effects widens. Both statesmanship and business sagacity now achieve their most brilliant successes here. In their strategies they seize upon the indirect, the incidental, the by-product. The largest results secured by the individual railroad man in free career are the indirect results to the community, the railroad business as a whole, or the particular railroad where he is employed, although the wages for which he works are paid directly for a very specific, direct product. He himself computes his achievement in

scale of earning power, but the wages which represent the direct effect to himself are mainly important because they are generally a fair index to the great body of indirect effects which go with them.

The community is interested in the efficiency of the individual railroad man because society as a whole is interested in the minimum of waste and the maximum of efficiency throughout all its parts. It has at its disposal a fund for educational purposes partly derived from tax levy and partly from voluntary contribution. Education is by no means so far socialized that the entire expense of fitting men for work is thrown into a common fund and then drawn back by the individual according to his requirements. A great part of the heavy burden of fitting men for work is borne by special agencies, local groups, the industry that recruits its men, and the individual himself. There is in fact some antagonism, on the part of school men, to the theory that the public school system should be held responsible for specialized forms of manual or industrial training. Dr. William Maxwell, city superintendent of schools, New York City, while an advocate of a legitimate emphasis upon vocational work in the schools, remarks in the course of his report for 1908: "Manufacturers who up to fifty years ago felt themselves responsible the world over for the training of their workmen, must not be permitted, under any pretext, to shift that burden entirely to the public school." Apart from this, there may be pedagogical reasons for believing that too much specialization may work direct social loss by warping the general learner too early to one kind of fitness at the expense of his power of adaptation, thereby actually unfitting him for any other possible lines of skill. The educator calls this "arrested development." If the boy is already at his vocation, the school may collaborate with the shop to increase his efficiency, but so far as the public school tempts to arrested development by too early specialization by those who otherwise would take broader courses, it tends to reduce the flexibility of industrial society.

The next question—how far specialization for a particular industry, such as railroads, can be carried at the common expense—is simply a question of how far the specialization of the time and effort of young men, and the machinery and expense of the educational plant, can go in one direction without ignoring equally crying demands for efficiency in other directions. Local conditions must largely determine this. A high school course in pottery at Trenton, or in mining at Denver, or in the textile industry at Lowell, or in agriculture at Wichita, or in railroads at Altoona, does not seem incongruous. But a course fitting metallurgists in Washington, or bankers in Butte, or railroad men in Mobile might be at the expense of some more pressing local need.

INDIVIDUAL EDUCATION AND THE RAILROAD.

Next after the community, in order of interest in the education of the railroad man, comes the railroad as a whole or in territorial groups. The distinction between the railroads as a whole or in groups is merely one of degree. The effects which we are locating are, as we have said, the indirect effects—those which in time, or place, or outcome are remote from the immediate effect sought. The bowman can afford to shoot at random if his archery field is so wide as to include the farthest flight of his arrows, so that he may gather them again into his quiver. Thus, the wider the scope of a business, the more the indirect effects that fall within the area of its operations. To the short-sighted railroad management the education of individuals does not make so obvious a case for itself as education *en masse*. As we noted above, when the worker is individually raised to higher efficiency he is at the same time raised to higher earning power; the railroad employing him must pay for the increased efficiency or lose it to the competitive road which will pay this price. These considerations notwithstanding, there is a considerable direct advantage to the railroad before we come to the area of indirect advantage. Thus with perfect freedom of employ, there is much immobility of labor which will offset real wage disparity. In addition to this, the increase in wages of the individual worker, under ordinary conditions, does not at once absorb all his added efficiency. This becomes more and more true according as his work involves the use of a large tool or fixed plant whose entire efficiency is never all exhausted. The modern efficiency wage systems, however, would rule out the second of these advantages, and divide the third between the worker and the railroad. They leave us, however, with the area of indirect advantages unimpaired. It is the testimony of every practical railroad man that inefficient labor at any price is extravagant, and that efficient labor even at high prices is economical. Even in case of materials it is generally found economical to use the best grades of material of specific adaptation.

But the social character of railroad work gives added effect to efficiency at any one point in the organization. Such efficiency serves as a pacemaker. The railroad, therefore, is so greatly interested in the highest possible grade of workmanship that even after it has paid the efficiency wage it has left a large unabsorbed balance of advantage on which to draw for creating more and higher efficiency. If this process of efficiency making can be intimately related with the current routine it produces a great secondary effect in stimulating the interest, application, and efficiency of the great body of workers; there is bound to be a steady intellectual ferment in the whole body where the brighter and more industrious are leading the way.

SOME EDUCATIONAL NEEDS OF RAILROADS.

Education is based on the best practice. Hence it requires a constant comparison and study of "best methods," bringing all practice into the area of competition for approval. It must constantly chart and rechart usages. It must evolve its theory of practice, and open the way for discovering underlying relations. Certain kinds of efficiency, of which the railroads are in great need, must come largely in this way. The social and economic problems of railroad operation are left in great measure to the chance publicist, whose information and method may be most unreliable. The railroad staff to-day is entirely lacking in the highly trained, practical man to master the intricate social problems which the great railroad has opened up, and practically to relate them to the financial, commercial, and operating policies which are the everyday routine of management.

Railroads need, as never before, broadly educated directorates and executives. This to-day is the weakest side of railroad organization. It shows itself, in connection with the present discussion, by inability to appreciate the possibilities education offers to increase the net income accounts of the railroads. The power intimately to connect the present to the future, and trace causes through the intricacies of indirect effects and over long periods of time, is not at present highly developed. For this reason, education as a department of administration in handling great bodies of workers has been largely ignored. Appropriations for this purpose are still viséed with suspicion, if made at all.

EDUCATIONAL EXPERIMENTS AND RAILROAD COOPERATION.

The Canadian railroads were the first to take the matter practically in hand and treat it on broad lines. A group of the roads centering in Montreal undertook, in 1904, to guarantee $15,000 a year for ten years to install and maintain at McGill University a railroad department. The plan, the details of which will be found noted under "Higher education," contemplates a very close relation between the railroads and the university, providing for terms of employment on the railroad in different departments during the course, and for permanent employment, under proper conditions, on graduation.

Roads centering in Chicago have undertaken, in a less formal way, to lend their cooperation to a railroad course under the auspices of the University of Chicago. At the University of Illinois very cordial relations are maintained between the railway engineering department and the railroads, especially the Illinois Central. This road owns jointly with the university a dynamometer test car, which has been operated by students over the entire Illinois Central System, as well as on the lines of the New Jersey Central, the Baltimore and Ohio,

the Cleveland, Cincinnati, Chicago and St. Louis, and the New York Central railroads. Apart from the advantage to the students of this cooperation, the point to be here noted is that the tests made were equally for the information and to the advantage of the roads. The University of Illinois also runs an electric test car over the lines of the Illinois Traction System, an interurban service.

The Pennsylvania Railroad has spent $40,000 on the installation of tools and machinery at Altoona High School for the instruction of railroad apprentices. It holds its available men in the great shop subject to draft by the school for practical talks.

Purdue University has for many years enjoyed close relations, in an informal way, with the railroads. It has provided a testing depot for the Master Mechanics' Association, and its faculty have held themselves in readiness for theoretical discussion of practical questions. In turn the railroads have let its students into their shops as special apprentices, and railroad officials have given practical talks.

Correspondence schools, as we shall have occasion to state elsewhere, have been given recognition by railroads, which have collected their tuition fees through the pay rolls, referred employees to their courses, and informally attached significance to the credentials which the schools confer upon those completing their courses.

The Young Men's Christian Association has been among the most useful of the agencies offering to the railroads a machinery for such educational efforts as they saw fit to undertake. The work, beginning as welfare work, has now grown to include a highly organized educational department, with standard educational courses, methods, instructors, examinations, and diplomas. The degree of cooperation between the association and the roads is special in each individual case. Sometimes it is merely a cash contribution by the railroad; sometimes to this is added a building and its maintenance; latterly instructors' salaries have been paid by the railroads.

The apprentice system now installed on the New York Central lines (see "Apprenticeship") is the most serious effort so far made by any railroad. Here the railroad has boldly undertaken itself to instruct its apprentices, through the entire course of apprenticeship, by company instructors and during company time. Figures are not publicly available, but they have already been collected, and they show—so far as estimates could be made—a very handsome financial return on this outlay. From practical knowledge of working conditions on a railroad, the writer estimates that no other outlay on any railroad approximates the yield on the investment which the New York Central enjoys on its appropriation for educational purposes. But such work is prudent only when the directors will commit themselves to a policy covering not less than five years, and will support such policy with vigor. Railroads have much to learn from

the more intelligent administration of large industrial plants which deal with very similar conditions. The educational department of the Westinghouse or the General Electric Company is as fully established and recognized a department of the company's operations as is the drafting room or the general manager's office.

V. APPRENTICESHIP.

Apprenticeship had formerly a definite significance; it was an indenture between master and apprentice, covering a period of years within which ordinarily the advances made by the master during the learning period could be repaid at the latter end by the excess value of the apprentice above his contract wages. It thus served as a safe basis of cooperation and was given legal force. In practice, however, such extended contracts impairing the liberty of individuals ceased to be in accord with the spirit of the times, and they came to be superseded by an agreement which was of purely voluntary force. Its observance rested on general conditions of self-interest throughout the period covered and on the force of custom.

Apprenticeship as now understood has the following characteristics:

(1) It is a status under special contract, more or less formal, wherein the employer undertakes to give the apprentice special opportunity to learn, and the apprentice accepts less wages than he might otherwise earn directly.

(2) The arrangement covers a stated period, supposed to be long enough for the apprentice to learn the trade and perhaps to give some skilled service to his employer in the latter years of his apprenticeship.

(3) The arrangement contemplates the fitness for a particular trade or some more or less definite area of skill.

(4) The apprentice receives credentials at the end of his service, which place him in a class in which the individual enjoys, more or less arbitrarily, the earning power of that class.

(5) The form of apprenticeship contract is frequently a matter of quite definite understanding between the employer and the general body of workmen in a given trade, and it sometimes includes a provision limiting the number of apprentices.

Apprenticeship on railroads at the present time is generally limited to the mechanical department. In a few cases there are regular apprentices in the roadway, bridge, and building departments, and in the transportation department among telegraphers and station agents. In the train service and in the accounting department

there is frequently a kind of apprenticeship based on the fact that the order of entry in the service and the initial stages of promotion are rather rigidly laid out; but this provision differs from the regular apprenticeship system in the fact that there is no fixed period for the apprenticeship, nor any implied contract to produce a man of a class-earning power in any given time. The apprenticeship system is particularly identified with the mechanical department, because that department requires a highly specialized skill of a fairly standard character.

The simplest form of railroad apprenticeship is a very loose arrangement. It is little more than the designation of a general form of apprentice contract. It practically amounts to a declaration of policy, which it is left to the division officers to interpret and execute in their own way.

Starting with the above arrangement as a beginning, the stages of amplification are—

(1) Creating a department for special supervision of apprentices:
  (*a*) Prescribing detailed course of work.
  (*b*) Having oversight of individual apprentices.
  (*c*) Giving periodical examinations.
(2) Incorporating instruction in the course:
  (*a*) Allowing time credits for outside instruction.
  (*b*) Requiring outside instruction in designated schools and partly or wholly bearing the expense.
  (*c*) Conducting the schools themselves and making attendance compulsory.
    (1) In night schools.
    (2) In schools maintained in working hours on company time.
(3) Offering cash bonuses for excellence.

With the enlargement of railroad working bodies the personal relation of the master mechanic and his men necessarily became less intimate. The apprentice boy ceased to enjoy the close oversight and interest of the master mechanic. In the pressure of current business the training of apprentices on American railroads came to be seriously neglected. From time to time the mistake that was being made was pointed out by those concerned in the mechanical department, but with little result. In 1898 the American Association of Railway Master Mechanics sketched three courses of apprenticeship for shop boys and laid out an approved form of agreement, which was amended in 1904.

CODE OF APPRENTICESHIP RULES ADOPTED AS THE RECOMMENDATION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION IN 1898.

1. A regular apprentice is one who has had no previous shop experience and is not a graduate of a technical institution.
2. No regular apprentice shall be taken into the shop below the age of 15 or after the age of 19 years.
3. No apprentice shall be taken into the shop who has not received the elements of a common-school education, and who does not give evidence of such capacity as to promise the ability to become a competent mechanic.
4. No apprentice shall be taken into the shop without the consent of his parents or lawful guardians, who shall execute such documents, including a release of the company from liability for accidents to the said apprentice, as the company may require.
5. The term during which an apprentice shall serve before receiving a certificate of apprenticeship shall not be less than three years nor more than five years.
6. There shall be a regular apprentice course framed for each shop, which course each apprentice shall go through during his term, the time to be spent on each class of work being defined, and such definition shall be observed as closely as practicable with due regard to the capacities and condition of the individual apprentice.
7. During the term of the apprenticeship a careful and proper record shall be kept of the work and progress of the apprentice, and also of the general behavior and conduct, which record shall be entered on properly authorized blanks or books provided for the purpose, not less frequently than once every week during such term.
8. Each apprentice shall be paid for the work done by him upon a scale duly agreed upon and provided for in advance.
9. Under no circumstances shall the company assume any liability for the employment of an apprentice after the conclusion of his term.
10. On the conclusion of the term of apprenticeship, each apprentice shall be given a certificate in proper form, duly signed by the proper officer of the company, which shall set forth the length of the time which each apprentice has served and the work on which he has been engaged, as well as some indication of his general behavior during his term.
11. Apprentices who have already served part of a term in other shops, or who have taken part of a course at a recognized technical institution, may be received under such modifications of the foregoing rules as may be deemed proper.

RECOMMENDATION SUPPLEMENTARY TO THE CODE OF APPRENTICESHIP RULES.

Rule 3.—An apprentice should be able to read and write and have a knowledge of arithmetic. Some companies insist that a candidate shall have reached a point in his studies equivalent to that of the eighth grade of the public schools. This standard where applicable will be found satisfactory.

Rule 4.—(A form of release of minors.)

Rule 5.—Four years is recommended as the best standard time. Whenever possible this should be adopted. The limits given in the rule "not less than three nor more than five years" are made sufficiently wide to cover all special cases. The brightest and most ambitious boy should not be permitted to complete his course in less than three years under any circumstances. A boy who does not complete it in five years had better be something else than a mechanic.

Rule 6.—The following courses are recommended for the various shops:

Machine Shop.

Tool room.—General uses of tools, names, etc., work on small planer, drilling machine, shaper, and lathes; provide tools; six months to actually serve.

Erecting shop.—Helping on general work—gang No. 1, one month; helping on general work—gang No. 2, one month; helping on general work—gang No. 3, one month.

General instructions, milling machine, boring mill, horizontal machine, axle lathe, and helping in general; three months to actually serve.

Boring, driving, and truck brasses and quartering machine, two months. Cylinder boring machine and planer, one month.

Rod.—Rod gang, three months; small lathe (alone), two months; large slotter, one month; brass lathe, two months; small planer, one month; large and small planers, two months; driving wheel lathe, one month; large lathe (alone), one month; general vise work, three months; surface table, three months.

Erecting shop.—General work—gang No. 1, five months; general work—gang No. 2, three months; general work—gang No. 3, four months.

Total months of actual service—forty-eight.

Your committee submits this as a basis for an adequate course of training in the machine shop, with the distinct understanding that it is to be qualified so far as the term of service to be spent in the different items, and also in the whole course, by the quality and capacity of the individual boys, under the discretion of whoever has them in charge.

Blacksmith Shop Course.

1. To start the apprentice on a bolt machine for six months. Here he will learn the rudiments of heating iron; also the setting and adjusting of dies, and at the same time by observation will learn the names of the tools and their use in that portion of the shop.
2. The next six months in operating a steam hammer. In this position he has a good opportunity to note how the blacksmiths handle and form iron; at the same time require him to help at the fires in the immediate vicinity of the hammer.
3. The next six months should be as a helper on a small fire, with a man who is quick and handy with light work.
4. The next six months on a light fire without a helper, where he will learn to handle the hand hammer.
5. For the next three months give him a light fire with a helper; the fire should be so located that he will be called upon to assist in taking heats for the larger fires.
6. For the next six months on heavier work that does not require skill.
7. For the next three months put him helping at the tool-dressing fire, and if the shop has two tool-dressing fires, the next three months on the second dressing fire.
8. The next twelve months put him on a heavy fire with as much of a variety of work as can be arranged.

Boiler Shop Courses.

1. The first three months heating light rivets.
2. The next three months helping on the heavy sheet and iron work, such as wheel covers, ash pans, etc.
3. Three months holding on rivets for tank work.
4. Three months holding on rivets for boiler work.
5. Six months riveting on patches, chipping and calking on tank work.
6. Six months setting flues.
7. Six months patching and bracing boilers, chipping and calking, and general riveting.
8. Six months blacksmithing to learn how to make and fit braces, to dress necessary tools, and assist in fitting work.
9. The fourth year to lay out flange and do general boiler work.

Rule 7.—It is recommended that some one person be given direct charge of all apprentices and be held responsible for their proper instruction. He can be known as the "Foreman of the apprentices," or he can be designated to perform the duties without special title, in conjunction with his ordinary work. [The committee recommended a blank form of individual apprentice record showing the markings, by weeks, on scale of 100.]

Rule 8.—The scale of pay must be governed largely by geographical and individual conditions. It is recommended that the rate of pay be 50 cents for a ten-hour day for the first year, with an increase of 25 cents a day for each year thereafter. For an eight-hour day 40 cents a day at the start and 20 cents a day increase yearly.

Rule 9.—The following form of certificate is recommended:

[Form of certificate of apprenticeship.]

A. B. C. Railroad Company, Motive-Power Department.

CERTIFICATE OF APPRENTICESHIP.

..... has served an apprenticeship as ..... at the shops of this company at ..... during the period from ..... to ..... and has made .... hours' time over ten hours per day.

Work on which employed:

Approximate number of months:	Kind of work:
.....	.....
.....	.....

Officers under whom employed:

Name ..... Title .....

General record of apprentice:

....

Superintendent Motive Power.

Where roads have given the matter any attention at all, they have each emphasized some one feature, but it is safe to say that, until very recently, comprehensive, thorough work was universally lacking. The Barnard undertaking on the Baltimore and Ohio, in the eighties, never reached a full working basis. The failure here only served to lend the suspicion of impracticability to all such efforts. The Pennsylvania Railroad was the most forehanded. It featured the "special apprentice," who was carefully selected and trained for official position by a sequence of promotion.

In the early eighties, the railroads began to look about for scientifically trained men for mechanical superintendents. The technical school was supplying the theoretical education. Sometimes the graduates of these technical schools made their education practical by adding the drill of the three or four years of a common apprenticeship; sometimes they avoided the apprenticeship altogether, and acquired their practical education in the course of experience. However the service was entered, the efficiency of these men came to displace the rule-of-thumb skill of the old master mechanic. The gap between the skill of the bench and the skill of the new type of master mechanic became apparent. Emphasis was placed on the quality of the

superintendence, and the skill of the rank and file was left to take care of itself. Meanwhile the division of labor went on apace. The handy man and helper became more in evidence, the all-round mechanic less frequent.

G. M. BASFORD'S APPRENTICESHIP PLAN.

The dangers of the situation were recognized by all, but little serious thought was devoted to the apprenticeship problem until Mr. G. M. Basford brought the question to the fore. His paper, before the American Railway Master Mechanics Association in 1905, was a vigorous arraignment of the unsystematic methods of recruiting the service. He described the mechanical department as a pyramid resting upon an apex of highly trained efficiency, liable to topple over with crushing weight whenever the poise by any chance was disturbed. He found the highest type of apprenticeship and technical education in the educational system of the British Admiralty. "The method begins with apprenticeship, combined with schools and the naval college. By a process of selection, through healthy competition, ability is easily discovered, and those who are fitted are raised to the very highest positions. All pass through the sieve of selection, and those who wish to remain in it after its first shake must strive for the opportunity. They also receive shop instruction as apprentices."

Mr. Basford's proposition was to bring the school into the shop, not to try to carry the shop to the school. He would keep the apprentice from the first in the atmosphere of a real shop, where he is "working on company time." From the first he would put the apprentice under the compulsion of the commercial idea. He would widen his knowledge from the center outward, not from the rim inward—that is, he would present his rules, formulæ, and general principles in the terms of everyday shop routine and in the sequence in which the worker runs across them in the requirements of his work. Thus, if a boy is set to handle nuts, he would have him discuss the strength of material used in the nut, its coefficient of expansion under heat. He would have him sketch it on a pad, draw it to scale, plot the geometrical formulæ involved, and learn the mechanical principle of the lever and the wedge, so far as it applied. He would teach the apprentices by a foreman, or one who could be a foreman, and instead of textbooks he would use a series of specially devised problems such as actually arise in the course of the work upon which the apprentice is engaged.

APPRENTICESHIP ON NEW YORK CENTRAL LINES.

The general plan outlined by Mr. Basford was immediately put into effect in the mechanical department of the New York Central Lines. Mr. Deems, the superintendent of motive power, had the full support

of the management, especially of Mr. W. C. Brown, then senior vice-president. The execution of the plan was committed to Messrs. Cross and Russell, the one a practical man who for several years had been assistant master mechanic, and the latter a technically trained man. Mr. Gardiner, of the Massachusetts Institute of Technology, but also shop trained, has since succeeded Mr. Russell, who was called elsewhere.

The New York Central apprenticeship plan deserves extensive reference because it has been most seriously and deliberately undertaken; has already, in three years, secured results which forecast much larger results; and has served as a pattern for the Atchison, Topeka and Santa Fe, the Union Pacific, and the Canadian Pacific railroads. It contemplates, in the first place, a general supervision of apprentices, but under local control on the several divisions. The railroad furnishes the instruction, which is made compulsory, and is carried on during shop hours. The instruction is by the "problem" method and is severely specialized to the requirements of the road. The instructor is preferably a draftsman, assistant foreman, or other regular employee assigned to the duties of instructor. The course requires home study. It is laid out in the form of general leaflets prepared at headquarters, but each apprentice works through it individually as fast as he may. Because the instruction is so highly specialized, it is not possible to define, on the scale of the text-book or usual school work, the range of the "problems" treated. The backbone of the course naturally is mechanical drawing. The apprentices learn to make sketches and read drawings, and some of them later specialize in this branch. There are no examinations except upon entrance. The work is individual for each apprentice. There are no classes, though they do work in groups. The instructor marks each apprentice monthly on general efficiency and regulates his progress accordingly. The courses are three and four years, with an allowance up to a possible two years for special work. Candidates for apprenticeship must have had a common-school education and must meet certain physical standards. For the first six months they are on probation. On the completion of apprenticeship the company issues a certificate which serves as a preferred credential in seeking employment on the New York Central Lines. There are no special apprentices, except that after the first two years the brightest men are selected for what are termed "general apprentices." To them are given special courses, with a view to fitting them for foremen and shop superintendents. These are the main lines of the plan, which is deemed so important that the regulations, schedule of work, and illustrations of problems are given below in very full detail.

No apprenticeship system can be successful which does not secure the full confidence and support of the division officers and of the body of the shopmen. In this respect the New York Central system has been especially careful. The shopmen of every type are in full sympathy with it because the company emphasizes that the undertaking is "on the square" and is not a subterfuge to create an excess of skilled men. The division officials and general officers see already a large enhancement of efficiency. The pay of apprentices is on a fixed progressive scale. In the absence of bonuses the apprentice is stimulated by letters of recognition for excellence, bearing the signature of the superintendent of apprentices.

Regulations of the Department of Apprenticeship, New York Central Lines.

A. Boys under 17 or over 21 years of age are not to be accepted for employment as apprentices.

B. Whenever possible, preference shall be given to sons of employees.

C. Applicant must pass a medical examination, before the local medical officer, proving him to be sound physically and mentally. Eyesight not less than 20/30 in each eye, free from color blindness, and hearing not less than 20/20, or a similar examination in accordance with regulations that may be adopted.

D. Applicant must have a good common-school education, sufficient to enable him to read and write the English language, to make out his application on a blank provided for the purpose, and to enable him to make the ordinary computations in simple arithmetic, including addition, subtraction, multiplication, and division of numbers of four figures, and must have a reasonable knowledge of common and decimal fractions.

E The chief officer at each shop will make the selection of apprentices from the applications, in conjunction with a representative of the department of apprenticeship, who shall sign the application paper.

F. Each year of the apprenticeship shall consist of 300 working days worked; no allowance will be made for overtime, and the subject of allowance for time lost by the apprentices will be considered in each case, and if worthy the applicant will be given the next advance in rate by calendar time. In computing time for next advance in rate, a day shall be allowed for each day or part of a day worked, provided it is not less than the hours run at the shop. (It should be understood that this refers only to computing time for date of next advance in apprentice rate and has no reference to or bearing on the prevailing system of computing time of employees on the hourly basis for wages paid.)

G. Credit in rate and time, not to exceed two years, may be given for previous work of the same class as that for which the apprenticeship course is served. Such credit is to be given only after written approval of the superintendent of apprentices.

H. Applicants not showing an adaptability for the work should be dismissed as apprentices during the first six months, and may be transferred to other employment. Foremen and local instructors should pay particular attention and report instances of this kind.

I. Apprentices to be subject to the same regulations in regard to discipline as any other employee of the company.

J. At the expiration of apprenticeship, those who have satisfactorily completed their term shall receive certificates signed by the proper officials of the New York Central Lines.

K. Apprentices who have completed their courses as indicated by the award of the above-mentioned certificate, may continue in the employment of the company at such rates as their services are worth. They will be encouraged to continue their services at a shop other than the one in which they have served their apprenticeship. After gaining experience in another shop, they may be transferred to their home shop if desired. In employing mechanics at all shops, preference will be given those holding New York Central Lines apprenticeship certificates.

Mr. R. V. Wright, in the American Engineer and Railroad Journal, for October, 1907, has made a very careful report on this apprenticeship course of the New York Central Lines. Speaking of the courses in general he says:

The Apprentice Courses or Schedules.

As may be seen, these schedules are sufficiently flexible to meet the needs of the various grades and types of boys who may be enrolled. The shop instructor is responsible for seeing that they are "lived up to," and he must give reasons for any deviations from them. He usually has a schedule for the changes in his shops arranged for a considerable period in advance. He keeps in close touch with the various foremen and carefully studies the situation in the shop, so as not to cripple any one branch or department by making too many changes at one time, or by reducing the quota of boys in a department without taking the proper steps to keep up the work. When changes are necessary he submits his recommendations to the shop superintendent, who approves them and issues the necessary orders to make them effective.

Machinist, boilermaker, tin and copper smith, and painter apprentices are to be assigned to the roundhouse for short periods during their apprenticeship. Those who show a liking for drawing are assigned to the drawing room, to assist the shop draftsman, for periods of from sixty to ninety days. At the Brightwood shops of the Big Four the general foreman, Mr. Bauer, is making a practice of taking some of the apprentices into his office, for a short time, to enable them to become familiar with the methods of keeping records and office work in general.

The appended outline is the road's official schedule:

Apprenticeship Course, New York Central Lines.

The following is the regular course of apprenticeship for the several purposes, which should be adhered to as closely as possible, and regular reports covering the subject made in accordance with notation on each report of any variation from this schedule and the reason therefor. Roundhouse experience shall be given apprentices in the machinist, boilermaker, blacksmith, tin and copper smith, and painter trades.

MACHINISTS' SCHEDULE.

Four-year course.

Helping in shop	0 to 3 months.
Bench work	6 to 12 months.
Light tool work	3 to 6 months.
Heavy tool work	3 to 12 months.
In one of either air-brake department, tool room, or brass room	3 to 6 months.
Erecting shop	18 to 24 months.

This schedule allows fifteen months above the minimum in the various departments, which can be divided between those on which the apprentice shows most adaptability.

BOILER-MAKERS' SCHEDULE.

Four-year course.

Heating rivets, etc	3 to 6 months.
Light sheet-iron work	12 to 15 months.
Flue work	3 to 6 months.
Riveting, chipping, calking, and staybolt work	12 to 18 months.
Flanging and laying out	0 to 3 months.
General work	6 to 12 months.

This allows twelve months above the minimum in the various departments, which can be divided between those on which the apprentice shows most adaptability.

BLACKSMITHS' SCHEDULE.

Four-year course.

Hammer work and helping	3 to 12 months.
Light fire	12 to 24 months.
General work	12 to 24 months.
Heavy fire	3 to 12 months.

This leaves eighteen months above the minimum in the various departments, which can be divided between those on which apprentice shows most adaptability.

MOLDERS' SCHEDULE.

Four-year course.

Helping	3 to 6 months.
Core work	6 to 12 months.
Light work	6 to 12 months.
General molding	18 to 24 months.
Dry sand	1 to 12 months.

This leaves fifteen months above the minimum in the various departments, which can be divided between those on which apprentice shows most adaptability.

PATTERN-MAKERS' SCHEDULE.

Three-year course.

Helping in pattern shop	0 to 3 months.
Foundry	3 to 6 months.
Machine work	3 to 12 months.
Bench work	24 to 30 months.

This allows six months above the minimum in the various departments, which can be divided between those on which apprentice shows most adaptability.

TIN AND COPPER SHOP SCHEDULE.

Three-year course.

Helping around shop	0 to 3 months.
Pipe work	6 to 12 months.
Sheet-iron work, including jackets	6 to 12 months.
Tinware	6 to 12 months.
Coppersmithing	6 to 12 months.

This allows twelve months above the minimum in the various departments, which can be divided between those on which apprentice shows most adaptability.

PAINTER APPRENTICES' SCHEDULE.

Three-year course.

Helping	6 months.
Burning off and sandpapering and truck work	6 months.
Rough stuff and coating	6 months.
Staining, graining, and varnishing	6 months.
Striping, lettering, and designing	12 months.

PLANING-MILL SCHEDULE.

Three-year course.

Helping	1 to 4 months.
Running simple machines, including sharpening and setting tools	12 to 20 months.
Running more complex machines, including sharpening and setting tools	12 to 20 months.
Laying out work and templates and working from blueprints	16 to 28 months.

CAR-BUILDERS' SCHEDULE.

Four-year course.

Helping around shop	0 to 3 months.
Trucks	6 to 12 months.
Platform	6 to 12 months.
General body work	18 to 24 months.

Quoting again from Mr. Wright's article, though with some condensations for the sake of brevity:

Drawing Courses.

The method of teaching mechanical drawing differs radically from the methods ordinarily used, whether in special drawing schools and classes or in technical schools. No preliminary geometrical exercises are introduced, but models or actual parts are used from the very first and every step taken is along practical and common sense lines.

GENERAL INSTRUCTIONS.

When the apprentice reports to the drawing school for the first time he is given a drawing board, which is numbered and must be placed in a corresponding space in the case when not in use. He is told to place his name on his T-square and other supplies, is briefly instructed as to the use of the drawing board, T-square, and scale, and is told how to sharpen his pencil and impressed with the necessity of keeping it sharp. These instructions are made as simple and brief as possible, after which he is given a blueprint sheet, about 5½ by 9 inches in size, showing how his paper is to be placed on the drawing board and laid out, how the views of the object are to be arranged on the sheet, and the arrangement of the title in the lower right-hand corner.

He is then handed an instruction sheet and model for the first exercise and is told to go ahead. Usually the first drawing is completed two hours after the boy first reports. The instruction sheets are blueprints, 5½ by 9 inches in size, and contain directions as to just what is to be done, thus relieving the instructor to a considerable extent and enabling him to give his attention to each boy as he may require assistance. The instructor must O. K. each drawing before it is removed from the board, and as soon as one is completed he gives the apprentice the instruction sheet and model for the following one. The first exercises are very simple, but they gradually grow more and more difficult, geometrical principles being introduced as they are found necessary. Accuracy is insisted on from the start. Lettering is taught incidentally in connection with the title on the sheet.

Some of the drawing exercises are:

Exercise 2. A lap-joint detail.
Exercise 5. An anchor plate.
Exercise 7. Pipe center body.
Exercise 8. Planer block.
Exercise 13. Tool jig.
Exercise 14. Hose gasket.
Exercise 15. Vibrating cup.
Exercise 21. Brake nut.
Exercise 27. Hinge plate.
Exercise 35. Bolt with screw threads and hexagonal head.

Parallel with the drafting work is a course of study by a series of carefully graded problems which are to be worked out at home. They are prepared on loose sheets by a duplicating process and distributed from the office of the superintendent of apprentices.

When the solutions for one problem sheet are turned in the apprentice is furnished with the next sheet. The instructor keeps a record of the sheets which have been assigned and handed in, and follows the progress of each student closely. The solutions are retained by the instructor until the greater part of the class has covered the ground and are then returned to the students and become their property.

THE COURSES IN GENERAL.

The problems are not of the abstract numerical kind, but are such as are met with in the shops and drafting room, being clothed in the language of the shop. They are not classified as to subjects, as in text books; they are, of course, carefully selected and arranged, but this appears only after careful examination. The first ones are simple problems in addition, subtraction, multiplication, and division, these four subjects being mixed indiscriminately. They gradually become more difficult, taking up the different branches of mathematics, one at a time, but in such a way that the student hardly realizes that he is starting a new subject. In place of first stating the underlying law in abstract, and then giving an illustration, the problem is first stated and solved, and afterwards, if necessary, a law or rule is given. The student is required to work out a sufficient number of problems, of a similar nature, to make the idea take root from the fact of applying and using it. A running review is kept up constantly, as in the drawing course, by introducing problems which bring in points which were previously covered. The interest of the student is stimulated by varying the standard of difficulty and mixing the easy with the hard problems, as they are apt to come in practice.

Occasionally the instructor has the students go to the blackboard during the school session and assigns them different problems. This gives him an opportunity of finding whether they understand thoroughly the work which they have done on the problems and of pointing out errors and rubbing in any principles that are needed.

Two sets of problem courses are now in use, one for the locomotive department and the other for the car department; the problems in both these courses are quite similar, except that those which are distinctively locomotive problems have been omitted and replaced in the course for the car department. The problems as far as possible are based on actual figures which are taken from the company's drawings, standards, or records; from facts and data which have appeared in the technical press; from suggestions of motive-power officers; problems directly from the shop drafting room; hints from the instructors and points which may have come up in conversation with the foremen and mechanics. Each student is furnished with a copy of "Machine-Shop Arithmetic," by Colvin, and frequent references are made to this in connection with the different problems, which makes it necessary for the student to refer to it and encourages him in making use of it.

THE LOCOMOTIVE COURSE IN DETAIL.

The principles which have been followed in arranging these courses can best be illustrated by presenting a number of typical problems which have been selected from the course for the locomotive department.

3. If 6 castings weigh as follows, what is the total weight? 336 lbs., 403 lbs., 210 lbs., 357 lbs., 416 lbs., and 428 lbs.

Although the first problems are very simple they are stated in terms of the shop, and not in abstract, thus at once gaining the interest of the apprentice by giving him a practical application of the principles involved.

Problem. If the same job was divided equally among 25 men, how many even hours would each man work, and how much overtime would one man of the number have to put in to complete the job? Divide the time (377 hours) by 25, and the remainder will be the overtime required for one man.

$$
\begin{array}{r|l}
25 & 377 \\
\hline
 & 25 \\
\hline
 & 127 \\
 & 125 \\
\hline
 & 2
\end{array}
$$

15 hours for each man.
2 hours overtime for one man. *Answer.*

When the problem courses were first arranged, special instruction sheets were inserted illustrating the application of new principles as they were introduced. In revising the course it has been found advisable to discontinue this and as new principles come up, to present solutions of problems, in which they are involved, on the problem sheets themselves, as above.

9. If a casting can be machined at a cost of 67c., what will be the cost of machine work at the same rate on 9,726 duplicate pieces?
Multiply 67×9726.
Change from cents to dollars and cents.

In the above case the notation explains the steps which are to be taken to obtain the solution, but leaves the actual work of obtaining it to the student himself.

23. A ten-wheel locomotive has a weight of 47,026 lbs. on each pair of drivers and 20,880 lbs. on each pair of truck wheels. Find the weight of the engine.

In revising the problem courses it has been found advisable to use diagrams or sketches in connection with some of the problems to make them clearer and more interesting to the students. This will probably be done to a much greater extent as the courses are revised from time to time.

26. What is the footing of a pay roll per month, which shows 4,537 men each averaging 209 hours at a 29c. rate?

45. Find the weight of a round wrought-iron bar 2 5/16 in. in diameter and 9 ft. 6 in. long, if a piece 1 ft. long weighs 14 lbs.?

53. An order for cars is divided among four shops according to their capacity. At the end of three months the first shop has completed 1/10 of the entire order, the second shop 2/7, the third shop 1/5 and the fourth shop 3/10. What part of the entire order is completed?
Add 1/10, 2/7, 1/5, and 3/10.
70 is a common denominator, as it can be divided by 10, 7, and 5.
1/10=7/70, 2/7=20/70, 1/5=14/70, 3/10=21/70.

A brief note preceded the first problems in fractions, telling what they were and presenting the solution of an example in the addition of fractions. Similar notes and illustrations occur at intervals concerning the subtraction, multiplication, and division of fractions. The note in connection with the above problem illustrates the method of reducing fractions to a common denominator.

58. A drawing is to have two views placed one above the other. The upper view is 2 3/16 in. high and the lower view 1 9/16 in. high, and there is to be ½ in. between the views. If the space inside the margin of the drawing is 8 in. and the work is to be placed centrally on the sheet, how far down will the upper line of the upper view be placed? Show location by a sketch.

Note that the student is here required to present a sketch in connection with the solution of the problem.

61. The total weight of a 12-wheel passenger coach without passengers, but with equipment for electric lighting, is 107,960 lbs. 1/33 of this weight is due to the addition of the electric-light equipment; what was the weight on each pair of wheels before electric lights were added?

64. A private car weighs 55 tons. A sleeping car weighs 10/11 of the weight of a private car. A 60-foot passenger coach weighs 9/10 of the weight of a sleeping car. A pay car weighs 8/9 of the weight of a 60-foot passenger coach, and a milk car weighs ⅞ of the weight of a pay car. Find the weight in lbs. of the sleeper, passenger coach, pay car, and milk car.

75. How many 3-in. pieces can be cut from a piece of stock 29 in. long, and how many inches will be left if ⅛ in. is wasted per cut?

90. A tender loaded weighs 114,000 lbs. Its capacity is 10 tons of coal and 5,000 gallons of water. What would be its weight with 6 tons of coal and the tank 2/5 filled?

121. If a locomotive burns 1,200 lbs. of coal per hour when going at a rate of 18 miles per hour, how many tons of coal will be burned in going 99 miles at the above speed?

129. What is meant by a Prairie type locomotive? (Type J, New York Central.) Sketch diagram of wheels.

In each schoolroom a blueprint is posted showing the classification of locomotives according to the arrangement of the wheels.

145. With shops running from 6.30 a. m. to 5.15 p. m., with ½ of an hour for lunch, what would be the day's wage of a boy at 12½c. per hour?

149. What is the weight of a 7-in. channel 10 ft. long when the weight per foot is 1.75 lbs.?

Problem. A lot of screws weigh 69.3 lbs. What will 1/10 of the lot weigh? 6.93 lbs. Answer.

To divide by 10, move the point one place to the left.

163. If a bolt-heading machine has the following daily output for one week, what is the total amount to be paid the operator for his week's work at the rate of 13c. for 100 such bolts? 2,330, 2,060, 1,950, 2,420, 2,310, and 2,030?

166. A N. Y. C. tender frame is constructed with four 13-in. steel channels, each 25 ft. 9 in. long, weighing 40 lbs. per foot. Find the weight of steel channels needed for 18 frames.

198. A locomotive is to be extended 3 feet in order to gain heating surface and thus increase the steaming capacity. If there are 375 2-in. tubes, No. 11 gauge, how many sq. ft. of heating surface will be gained in the tubes? For the sq. ft. of heating surface per foot of tube length, see drawing plate S–44.

(Note: Heating surface is based on the outside surface of tubes.)

An example of how the problem and drawing courses are "tied together." Several illustrations of this will be found among the following problems:

202. If a planer makes a cutting stroke of 12 ft. in 20 seconds, what is the cutting speed of the tool in feet per minute?

204. A tank requires a plate which measures 8 ft. 10 in. long and 4 ft. 5½ in. wide. How would these dimensions look when placed on the drawing?

(See rule 14 of drawing instruction sheet posted in class room.)

208. Show by sketch the difference between a box car and a gondola car. Draw only an outline and do not show details.

215. The time between two mile posts is 74.6 seconds; what is the speed in miles per hour?

220. What steam pressure do locomotives now use? Tell where you get your information.

229. A micrometer caliper shows a piece to have a diameter of .678 of an inch. What would be the diameter expressed in the nearest sixteenth of an inch?

235. A blacksmith shop has a floor area of 37,026 sq. ft. If the width is 102 ft., find the length.

247. Find the weight of 25 sheets of ½-in. brass, each sheet measuring 16½ in. x 24 in.

(See problem 123.)

253. Show by a sketch what is meant by a crowned pulley.

259. Why are some pulleys crowned and some straight?

265. On a consolidation locomotive (Type G, New York Central Lines) (see drawing 870–73) how are the driving wheels usually named? Place the names on a sketch like that shown on the blueprint of locomotive classification. Also show which wheel the main rod connects with.

The above reference refers to the drawing course.

271. Find the number of sq. ft. in a roll of canvas 6 ft. 6 in. wide and 36 ft. 8 in. long.

284. Find the area of this ash pan side by dividing it into two triangles and one rectangle. Add the three areas. The area of the left-hand triangle is ½ x 12 x 8.

315. What is meant by a 4½ x 8 in. journal? Show by sketch which dimension is the diameter. See drawing plate 877.

361. From a sheet of Russian iron 8 ft. square, how many pieces 2 ft. square can be cut? Sketch the sheet and show cutting lines.

In finding the areas of circles in the following problems use table on page 137, "Machine-Shop Arithmetic."

367. Three oil cans are the same height; two are 10 in. in diameter and the third 15 in. in diameter. Will the 15-in. can hold more or less than the two others combined? (Compare the areas and show figures.)

395. A bar has a tensile strength of 70,000 lbs. per sq. in. Is it steel or wrought iron? Page 46, "Machine-Shop Arithmetic."

Preceding problem 401 is a note to the effect that the areas in the following problems are to be worked out:

404. Find the total pressure tending to blow the head out of an air drum 16½ in. inside diameter with 90 lbs. per sq. inch air pressure shown by gauge.

421. What would be the pressure on the entire piston of a 10-in. brake cylinder of a passenger coach in an emergency stop with a quick action valve, if the cylinder pressure is considered as 60 lbs. per sq. inch?

Preceding the introduction of percentage is a short explanation of what it is, together with a few typical examples showing how such problems are solved.

429. If a passenger coach with passengers weighs 94,950 lbs. and the passengers weigh 4,500 lbs., what per cent is the weight of the passengers of the total weight?

432. A drum head 21 in. in diameter is cut from a sheet of ⅛ in. plate 22 in. square. What is the weight of steel cut off? (⅛ in. plate weighs 15.3 lbs. per sq. foot.)

433. In the last problem, what per cent of the entire metal was wasted?

450. An axle originally weighs 1,038 lbs. and loses 6½ per cent when turned. What is the final weight? (Nearest pound.)

457. Four groups of men are being paid at the following hourly rates: 23c., 25c., 27c., and 30c. If the pay of each group is increased 2c. an hour, what is the per cent of increase?

461. A Pittsburgh and Lake Erie Class C locomotive with an Alfree-Hubbell valve has a piston displacement of 7,372 cubic inches. Find the cylinder clearance volume in cubic inches if it is 2.4 per cent of the piston displacement.

471. If enclosed Pintsch lamps consume ⅛ of a cubic foot per hour for each burner and open burners consume 1 cubic foot per hour, how many cubic feet of gas will be used during 7 hours on a sleeping car with 9 enclosed lamps of 4 burners each, 3 enclosed lamps of 2 burners each, and 4 single open burners?

474. A machinist apprentice planing wedges cuts ⅛ in. stock from each. If the surface cut measures 5½ in. x 9½ in., what is the weight of cast iron removed from 40 wedges?

For weight of cast iron, steel, and wrought iron, see page 46, "Machine Shop Arithmetic."

487. Find the weight of a hollow cast iron column 14 ft. long, 10 x 12 in. outside, and ⅛ in. thick. Add 75 lbs. for weight of cap and base.

496. Obtain a square bar of wrought iron from the instructor; take its dimensions and figure out the weight at home. Weigh piece at next class and hand in both results with a dimensioned sketch.

505. A 38-ft. tank car has a tank 93 in. inside diameter and 34 ft. long. What is its capacity in gallons?

522. Find the piston displacement, both front and back ends, of the following locomotive cylinders:
20½ x 26 in. with 3½-in. piston rod.
24 x 28 in. with 4½-in. piston rod.

544. On a 36-in. planer at West Albany the ratio of the cutting speed to the return speed of the table may be as 1 to 2.94. With a cutting speed of 50 ft. per minute, what is the return speed? (A ratio of cutting speed to return speed of 1 to 2.5 would mean that return speed was 2.5 times the cutting speed.)

546. The netting in the front end of a locomotive is made of wire marked No. 11 B. W. G. What is meant by B. W. G., and what is the diameter of the wire? (See blueprint posted in class room.)

547. A Class F locomotive has a netting in the smoke box 24 x 24 in., made of wire marked No. 11 B. W. G., with a 2½ x 2½ in. mesh. How much space in square inches is open for the passage of smoke and cinders and how much is taken up by the wire itself? (By 2½-in. mesh is meant that there are 2½ wires to each inch.) Ans.: Open 262 sq. in., wire 294 sq. in.

562. In setting valves without a valve-setting machine on a G-5 locomotive it is necessary to find centers by "pinching" and to give the driving wheels at least one complete turn. The locomotive has a total wheel base of 25 ft. 11 in. and 63 in. drivers. How long a piece of track must be available for the job?

In connection with the course, as outlined above, several extra sheets have been provided containing problems which are to be used where the student does not seem to have gained a sufficient knowledge of the subject from the problems in the regular course. These are assigned at the discretion of the instructor.

The instructors find it necessary to occasionally give short talks to the class as a whole, or to part of it, as new subjects are taken up. These talks are short, simple, and informal, and as far as possible objects are used as illustrations; for instance, each school is provided with a 1-foot cube with its surfaces divided into square inches and with a layer 1 inch thick removable. This is used in connection with the introduction of the subject of volumes.

SPECIAL BLACKBOARD EXERCISES.

A number of special problem sheets have been arranged on the subject of areas for use as blackboard exercises. The first problems are simple, but the latter ones are quite complicated and require a thorough knowledge of the subject on the part of the student for their solution.

EXPERIMENTAL WORK.

In addition to the main problem courses, such as outlined, two supplementary sets of problem sheets have been provided, dealing with experimental work which is carried on during the school sessions. One of these covers the subject of levers, the other valve setting.

Levers.—These experiments are worked out by two boys at a time. The first sheet in the series is as follows:

Obtain a light stick, rest one end on a block as a fulcrum, and hold up the opposite end of the stick by a spring balance.

5a. Hang a weight of 6 lbs., 5 in. from the fulcrum. Read the spring balance. Notice that the stick tends to turn down on account of the weight and that the balance tends to turn it up about the fulcrum. The weight × its distance from the fulcrum (6 × 5) is called the "moment" of the weight about the fulcrum. The balance pull × its distance from the fulcrum is called the "moment" of the balance pull, and this moment is equal to the moment of the weight, otherwise the stick will turn either up or down. A moment is always found by multiplying a force by an arm or distance, and the arm or distance is always at right angles to the force.

In this case multiply the reading of the balance by its arm 30 and see if this moment is equal to the amount of the weight (6 × 5).

The answer should include the following:

Reading of balance = ?

Moment of balance = ? × 30 = ?

Moment of weight = 6 × 5 = ?

Note.—The reading of the balance is the difference between what it reads before the weight is put on and after. This is because balances do not always read zero at start and also because the stick will show some weight. For example, if the balance reads 1½ lbs. holding stick alone and shows 2½ lbs. when the weight is added, the scale reading due to the weight would then be the difference between these weights or the increase in the reading, 2½−1½=1 lbs.

After a number of problems of this type have been worked out and checked experimentally, practical applications are considered, such as a forge crane, crowbar, belt shifter, reverse lever rigging, throttle lever, foundation brake gear, and track scales. A few problems in connection with the crowbar and throttle lever are as follows:

19. If a casting of 100 lbs. weight is to be lifted at B, and if D is 3 in., how much pull will be required at A? Make a sketch with dimensions.
20. If the casting at B weighs 100 lbs. and D is 6 in., what will be the pull at A? Make sketch.
21. If an iron bar at B weighs 500 lbs. and D is 3 in., what is the pull required at A to lift the bar? Sketch.
22. Which will move further when the weight is lifted in problem 9, point A or point B?
23. With D equal to 9 in. and B equal to 230 lbs., what is the pull required at A? Sketch.
24. What would be the pull in the above problem if the bar was only 4 ft. long instead of 6 ft.?
25. A locomotive is fitted with a throttle lever, like that illustrated, where C is 46 in. and B is 40 in. If the throttle lever stem (marked "to valve") is to have a motion of 1½ in., how far will the end of the handle move?

Mr. W. B. Russell, referring to his work, says:

It was predicted before we started this plan that the apprentice system would not last three months, and it probably would have failed, at least on the educational side, if the ordinary methods of instruction had been followed. The apprentice, as we find him, is not a man who can appreciate college methods or any adaptation of college methods to his case. High school training will not fit him. It has been necessary to start fresh from the beginning and develop a system of training to fit the special need we have here in America.

The two features of the work are the drawing courses and what are called the problem courses. Drawing courses for apprentices are nothing new, but our method of teaching drawing is different from anything I know of in this country. The geometrical work, which ordinarily takes a year or two in most evening schools, is omitted entirely. The boy starts immediately on practical work, being called upon to deal with actual conditions. The geometrical knowledge may be necessary, but is introduced as it is wanted. We do not teach him the principle and then let him apply it, but teach the application and the principle at the same time, the idea being to keep in view at all times the practical result to be gained. In our public school systems we have overlooked many important points. This work must go much slower than ordinary school courses.

The apprentice does not appreciate a lecture; it is wasted. The work must be individual; no system of teaching which requires the same standard from each apprentice will fill the bill. The standard must be an individual one; the quantity of ground to be covered is not an element in this. All of our public schools and high schools are intended to train for college, the high schools especially teach with that end in view, and our public school training is drifting into that line. In the case of the work we are doing we have no college requirements to meet. What we are trying to make in this instance are men, and the best method does not consist in the quantity of work they cover, but how they cover it. * * *

We have had to leave out everything in the text-books and have found it impossible to use them. There is nothing in this country at the present time to fit the needs of the apprentice, and it has been necessary to start from the beginning. The practical problem is first stated and solved, then followed by a sufficient number of similar problems to cause the principle to take root. In everyday life we do not have a classification of arithmetic, geometry, etc., but the problems are a combination of these subjects. It would be impossible, however, to take problems directly from the shop as they come up and give them to the apprentices, but it is possible to select problems that will slowly increase in difficulty and thus use actual shop problems in instructing apprentices. In doing this there is no subdivision into arithmetic and algebra. If the problem requires algebra for its solution the necessary amount will be introduced, but without the apprentice knowing it. At one of the points the boys found that they were working problems similar to those in the fourth year of the high school course and the result of the discovery was that they became frightened and did not do the work so well. * * *

[Our plan of apprenticeship] will work equally well with either piecework or day work. We have it on both plans. Specialization and not piecework is to blame for the present lack of apprentices. This plan will also work in a small shop, and we expect to put it in shops where there are only five apprentices. It may be in this case that the shop instructor and the educational instructor will be one and the same man, and will give only a small portion of his time to the apprentice work.

The unique feature of these problems is that they are presented in the local terms of the road. The car is a pay car; the planer is at West Albany; the locomotive is of Class F, New York Central. This

is adjusting the instruction to the need of the least trained. Such detail terminology is definitely an annoyance, one that must obstruct the more highly trained mind that is able to think in general terms.

The New York Central system, as we have seen, set out to have no "special apprentices." It makes allowances, on the regular apprentice scale, for outside work, but from that point on the course leads over the same ground. This rule, however, it has begun to break in the case of the "general apprentice." Supervision is in itself a specialty, and there is a possibility of clogging the equipment for that specialty with too great detail, or of acquiring it in too slow stages. The declared purpose, however, is to adjust the work to the needs of the majority, and let the exceptional man sift out of the mass. The spirit of democracy which the plan inculcates is most laudable, but a competitive system of selection into broad classes of capacity, which should be open to all upon equal terms, would facilitate the process of fitting men to their places, without compromising the equality of opportunity.

VI. SPECIAL APPRENTICES.

Apprenticeship of any kind is an effort to turn to account the educational value of routine work by putting it in some progressive sequence. The theory of allowing any man the advantages of apprenticeship is that there is a capacity in the man for a higher grade of work than that for which he is immediately fit, and that, with a little care in the order in which he is given his experience, he can acquire the skill to do the work which his real capacity renders finally suitable, and which is therefore the point of maximum efficiency.

The helper or the handy man who is denied apprenticeship is not able to acquire by successive stages the higher orders of skill, so that much of his capacity, if he has any, lies dormant and unused.

Ordinary apprenticeship erects among the workers a group who are treated on a slightly different basis from the rest of the workers. This discrimination is not for the purpose of personal favoritism or privilege, but is merely an adjustment to special conditions, in order to effect the largest equity and produce the greatest efficiency.

Special apprenticeship carries yet further the idea of grouping the workers according to some condition that shall in the long run make for their largest efficiency and so subserve best the interests of the general body of workers and the employer.

It differs from ordinary apprenticeship because it distinctly takes cognizance of the different native capacities among workers otherwise equally conditioned, and of fitness acquired elsewhere either by experience or by instruction. When the credits thus allowed are true indexes to differences of present fitness or ultimate capacity,

instead of being a device of favoritism, they are really only an ultimately equitable basis of apportioning opportunity.

Special apprenticeship is a device to classify the boys according to their ability to cover the same course in different time, and also according to the grade of service toward which their course is directed.

The New York Central's apprenticeship system accomplishes the first object even better by a method of individual instruction, but it specifically disavows the second object as undemocratic and subversive of the morale of the shop. As we have seen, it holds all its apprentices to the same course, and allows them to sift forward to their place of fitness and inclination by the selective processes of promotion.

The Pennsylvania Railroad, on the other hand, has for years trained its officials by this special apprenticeship course. To the extent that it may have set up impassable distinctions between the elect and nonelect, or made its selection on principles other than ability, it has of course been pernicious. But it has produced a body of officials which as a whole are not surpassed.

W. G. BERG'S APPRENTICESHIP PLAN.

The principle of providing separate courses for different grades of efficiency had a stanch advocate in the late Walter G. Berg, chief engineer of the Lehigh Valley Railroad. We quote from his paper before the New York Railroad Club:

> I wish to emphasize in the strongest possible manner that it is my firm conviction that the secret of the proper solution of the railway educational problem, as a whole, lies in making sharp distinctions and maintaining strictly the divisions between the educational plans for the various grades of railroad men. Most schemes, claimed to be general solutions, tend too much toward extremes—either shop and an apprenticeship only, or else the most advanced collegiate courses. Concessions are made by the advocates of shop training in the direction of night schools or shop instruction classes; while, on the other hand, the advocates of collegiate training seek to give their theoretical and scientific course a practical twist by introducing manual work departments and putting forward extravagant claims as to the practical advantages of turning out skilled workmen and scientists at one operation.
>
> I take the firm stand that heterogeneous elements can not be shaped in the same educational mold, and that combination systems can never meet successfully the educational requirements of all the various classes of railroad employees. In other words, any contemplated educational system should define specifically which grade of railroad men it is primarily intended for and be strictly arranged accordingly. Then the party who has a shop mechanic in mind could not taunt the advocate of a special collegiate course with the query, What good is calculus, theory of government, political economy and railway law to a shop mechanic? while, vice versa, the other party, having an education in mind preparatory for entrance into the general or professional offices of a railroad, could not retort by asking, Why waste years of a boy's life at a lathe? The much-vaunted and misunderstood manual-work departments of collegiate institutions would then be relegated to their proper sphere, namely, to serve as a practical illustrative adjunct to the class room.

We have in railroading, the same as in every business or industrial enterprise, three classes of men. The higher educated class leads and instructs the middle class; the latter supervises the work and carries out the infinite number of details connected with it, while the lower class furnishes the heavy manual work. The first class represents the experienced thinkers, organizers, and leaders; the second, the supervisors and skilled assistants or workmen; the third, the common labor.

By clearly defining the difference between the higher and middle classes of railroad employees and keeping the education of the two as separate and individual as possible, we have taken the first and most important step forward in the solution of the problem.

SPECIAL APPRENTICESHIP ON THE PENNSYLVANIA RAILROAD.

The Pennsylvania Railroad, at a very early date, took up the problem of preparing men for official positions. A class of "special apprentices" was formed. The initial distinction lay in the name, the preliminary training required, the age of admission, the rate of pay, the supervision, and the flexibility of the lines of movement. The special apprentices are trained for service in the system as a whole, so they are put under a general officer and located at the great Altoona shops, while the general apprentices are left to the care of division officers and are confined to division shops where first placed. The special apprentice is older than the general apprentice and does not often live at home, so it is necessary to provide him a living wage, which is higher than that of the general apprentice, who lives as a rule with his parents.

The special apprentice comes to the shop with credit for previous work in a technical school or college. The chief acquisition which his credentials are supposed to certify is the ability to "think straight." For the first two years the special apprentice takes practically the same course as the ordinary apprentice, except that he moves more rapidly. Then he is carried into special work outside the shop routine—work looking toward a fitness to inspect and supervise. The course is not rigid, but is generally followed as here outlined:

	Months.
Erecting shop	8
Machine shop	6
Vise shop	2
Air brakes	2
Roundhouse	3
Firing locomotives	3
Power plant	3
Car shop	3
Drawing-room and special work	6
Total	36

There is no parallel course of instruction nor any examination, but there is close personal contact. The special apprentice is called upon irregularly during his course for special investigations and

inspections, so that the character of his work in this way is brought out. For instance, a mountain branch line near Altoona was having a great deal of trouble with "break-in-two's." A special apprentice was assigned to make a study of the situation, devoting a month to it if needed, and report upon it with recommendations. The special apprentice is also drafted to assist at special tests and inspections. The sequence of such valuable special experience depends entirely upon the officer in charge. When the course is completed, the special apprentice is absorbed into the service, frequently as road foreman of engines. The very irregularity of the opportunities offered constitutes a certain element of discipline in personal resourcefulness and initiative in meeting situations as these develop and in developing the opportunities themselves. As Mr. Arthur Hale, former general superintendent of the Baltimore and Ohio Railroad, has said, "I was put in the water and told to swim." Mr. F. D. Crawford, general superintendent of motive power, Pennsylvania Lines, who was trained in the same school, refers to his course as simply, "I got in there," he says, "and was given a chance to dig, and I dug." Or again, we have it described by Mr. Gibbs, general superintendent of motive power, Pennsylvania Railroad, as, "The fellows learn that the longest poles knock the most plums."

In its civil engineering department the Pennsylvania Railroad has a system of careful promotion of its selected men. The young engineer's first responsible assignment is as assistant supervisor of a small branch division, and from there he moves to the same position on a main-line division. Next he is promoted to supervisor on a branch-line division, and from there moves back, as before, to a main-line division. In this way a valuable experience is acquired through the several grades and under a variety of operating conditions.

SPECIAL APPRENTICESHIP ON THE BALTIMORE AND OHIO RAILROAD.

The Baltimore and Ohio Railroad has three classes of apprentices. The apprentices of the first class have a four years' course, the pay each year being 8, 10, 12, and 15 cents per hour, respectively. These boys must have had a good common-school education and they must be under 18 years of age. They agree to attend an approved night school two evenings each week, taking elementary algebra and geometry the first two years and mechanical drawing the latter two years. The apprentices of the second class are high-school graduates. They must be under 20 years of age. As an offset to the high-school work they are allowed to omit the first year of the general apprenticeship course. The last two years of apprenticeship night-school work, however—in mechanical drawing and higher mathematics—are required. The apprentice of the third class is a graduate of a college or technical school between the age of 20 and 24 years. His allow-

ance begins at 14 cents an hour and is increased 2 cents per hour every six months, being at an average of 17 cents. He is not required to attend any night classes. His course covers two years.

The special apprentice has heretofore been confined to one department, and that, almost exclusively, the mechanical department. His opportunities for general observation have only followed in an irregular way after a high degree of specialization has been acquired in one particular branch of the service. The result has been what might inevitably be expected—that railroads have been weak on the side of highly trained administrative officials. In individual careers, occasional men have been given exceptional opportunities to pass through different departments and gain from such experience a coordinating sense of the railroad as a whole, which should serve later as the basis of efficient management. But these opportunities for extended observation have only fallen to the privileged lot of those who have been favored with some personal relation with the management, so that they can not be considered as part of a regular railroad organization, and, furthermore, the courses have been irregularly devised. The sequences offered in such special apprenticeships have been determined in each particular case by local conditions and personal relations. On some railroads a special division has come to be considered a training division. Thus, for instance, for many years the Staten Island terminals of the Baltimore and Ohio Railroad served as the college in which many junior officials of that road were schooled in the details of the art of management.

SPECIAL APPRENTICESHIP ON THE HARRIMAN LINES.

It has remained for the Harriman lines to boldly undertake a broad scheme of special apprenticeship looking to the training of administrative rather than technical talent. Referring to this work, Mr. F. G. Athearn, superintendent of railway clubs, who is in charge, writes:

> The instituting of this work on the Harriman lines I regard as one of the greatest movements of the times, both from an educational and sociological standpoint. It has been undertaken for the purpose of training up a body of young men to assume the duties of railroad officials who have as a foundation a broad general education which will serve as a background of *reserve* and *poise* and which will enable them to execute their duties, not only with proper regard for balance between the several phases of the business itself but also with a fuller and keener appreciation of the functions of the railroad as a public service institution. It is going to make for the extension of the horizon in railroad officialdom. It is going to make railroading a more exact science and add dignity to railroading as a profession. * * *
>
> [This course is] to fit young men to assume positions of responsibility in the management of railroad affairs, and to prepare them in such a way that they may have a working knowledge of the several departments and their interrelation, and that they may be *able to conduct the particular duties assigned to them in harmony with the scheme of railroading as a whole.*

The italics are our own, and they are intended to emphasize the philosophy on which any scheme of general training is based. Such training is to create a reserve of ability, as we have elsewhere noted, that will impart a coordinating quality to the man's work regardless of how detailed his assignment may be.

Referring again to the course, Mr. Athearn says:

> I am fully conscious of its many imperfections and already I am preparing to improve it. Before writing the course I made search among different colleges and technical schools offering courses in railroading for something that might serve our purpose, but all appeared inadequate, dealing either with the purely technical and mechanical side or with railroads in their relation to economic theories. What was needed and what I have tried to construct is a syllabus which would serve as a guide for students taking what might be termed a "post-graduate laboratory course in railroading."

The outline of work and reading for students constitutes in fact a "laboratory course," because it does not necessarily carry to the stage of finely trained routine efficiency in each department, but does set out the work in a progressive sequence and with sufficient thoroughness to give the apprentice a sense of familiarity with working conditions in the different branches, and enable him at the same time to preserve his perspective as he goes, by a parallel reading course. The apprenticeship is open only to those who have already acquired the power of systematic application, so that they need little more than a selected sequence of opportunities. They are, therefore, left largely to their own resources, except for a consulting relation with the officer in charge of students. The simplicity of the plan followed is indicated in the instructions to students, which are as follows:

INSTRUCTIONS TO STUDENTS.

1. The work of the several periods must be passed in the order outlined, unless special permission has been obtained to deviate therefrom.

2. Students will provide themselves with the books referred to as rapidly as needed. List price and publisher of each book is shown under the head of "Bibliography."

3. Each student must be a regular subscriber to at least one railroad publication of recognized merit.

4. Students will report in writing on the first day of each month to the officer in charge of students.

This report must be a full and comprehensive review and criticism of work and reading done during the preceding month.

Students should not hesitate to criticise adversely, commend, or suggest improvements. It should be remembered, however, that destructive criticism without the recommendation of something better is nothing more than fault-finding and as such accrues not to the benefit of the writer.

5. All correspondence should be addressed to the officer in charge of students.

6. Students will give notice to the officer in charge of students and to the head of the department in which employed, one month before the completion of any period, of the date such period will be completed.

7. Students will be graded on the basis of their monthly reports and reports of them given by their superior officers. In passing on reports, grammar, phrasing, and general literary structure will be taken into consideration.

8. Students will be subject at all times to the rules governing the particular work at which they are employed, and shall report to and be subject to the discipline of the officer in charge of any given department with which the student may be connected, in the same manner as other employees connected therewith.

9. Students shall be on duty during the entire working time of the month. All reading must be done outside of working hours. * * *

SYSTEM OF GRADING.

Grade 1.—95 to 100 per cent. Very rare and exceptional ability.
Grade 2.—85 to 95 per cent. Work, reports, application to duty, ability to learn, and general effectiveness, very satisfactory.
Grade 3.—75 to 85 per cent. Work, reports, application to duty, ability to learn, and general effectiveness, good, but could be improved without requiring "very rare and exceptional ability."
Grade 4.—75 per cent and under.

A student receiving an average grade of 4 for any period will be dropped from the student roll.

The numbers 1, 2, 3, and 4 only will be shown in markings by officials making reports.

The special apprentices are distributed through the service with the least possible interference with routine work. They are directly amenable to the local official under whom they may for the time be placed.

INSTRUCTIONS TO OFFICERS.

1. Officers under whom students may be assigned for service will see to it that students are given opportunity to pursue the work outlined in the manner and order indicated, unless special permission has been secured by a student to do otherwise.

2. All rules governing employees engaged in work of the same kind must be enforced as to students. Any infraction of the regulations in which the discipline would result in the dismissal of the party involved shall not be deviated from in case of a student.

3. In the event of the dismissal of a student from the service, the proper ranking officer will notify the officer in charge of students, giving date of dismissal and reasons therefor.

4. Officers having proper authority will issue to students assigned under them quarterly passes good on their respective divisions whenever the duties of the student are such as require such transportation.

5. Upon the completion of a period by a student, the head of the department or the superintendent of the division under whom this period was taken will render to the officer in charge of students a confidential report, giving his personal estimate of the student as to whether or not, in his opinion, he is a man who will develop into an efficient railroad official. This estimate should be based on personal observation; when this is not possible, upon reports from subordinate officers.

6. Officers will grade students in accordance with the scheme indicated under head of "System of grading," transmitting such grade with report required under No. 5.

APPOINTMENTS.

Any young man between the ages of 21 and 30 years is eligible to appointment to a studentship. Other things being equal, preference will be given, first, to college or technical-school graduates in the employ of the company; second, to men with common-school education in the employ of the company; third, to college or technical-school graduates not in the employ of the company.

It should be understood, however, that the appointment to a studentship does not carry with it a promise or obligation on the part of the company that the appointee will receive an official position upon the completion of the course. A student who has been graduated from the student class will be given preference in the filling of a vacancy, provided he is temperamentally fitted to meet the peculiar conditions of the position.

APPLICATIONS.

Applicants must state age, post-office address, whether married or single, address of parents, present occupation, educational qualifications, date graduated from institutions of learning, and degrees, if any; detailed account of railroad experience, if any; and give at least three, but not more than five, references to persons who are in a position to give testimony as to ability and moral character.

Applicants in the employ of the company should obtain the indorsement of their superior officers.

Applications should be addressed to the officer in charge of students.

CREDIT ON COURSE OF STUDY FOR EXPERIENCE.

Appointees who have had experience in railroading or technical training which, in the opinion of their superior officers, covers the work outlined for any one or more of the periods of this course of study will be allowed credit on account of such experience and the course shortened accordingly.

WAGE SCHEDULE.

Students will be paid in accordance with the following schedule:

First period, $80 per month; second period, $80 per month; third period, $85 per month; fourth period, $85 per month; fifth period, $85 per month; sixth period, $90 per month; seventh period, $90 per month; eighth period, $95 per month for the first four months and $100 per month for the last four months.

EXPENSE ACCOUNT.

A student will be allowed a personal expense account where his duties are such as ordinarily carry an expense account, upon the recommendation of the division upon which employed. Such expenses will be chargeable to the same account as student pay roll.

PAY ROLL.

A special students' pay roll will be made up by the officer in charge of students.

The amount of this pay roll will be charged off by the auditor to general expenses, as provided by the classification of the Interstate Commerce Commission.

A time roll for each student will be transmitted, properly approved by the head of department or division, directly to officer in charge of students.

The course covers three and a half years and is arranged as follows: First period, station service, six months; second period, maintenance of way, nine months; third period, master mechanic's office, six months; fourth period, student brakeman and conductor, five months; fifth period, signal engineer's office, two months; sixth period, store department, two months; seventh period, accounting department, four months; eighth period, with trainmaster, eight months.

As the first serious effort to plot out a systematic course among all departments for special apprentices the syllabus is reproduced here in detail.

First Period—Six Months.

Student in Station Service.

A.

1. Receiving, trucking, marking, and preparing freight for loading and unloading.
2. Loading and storing freight in cars; juxtaposition of different commodities.
3. Station order loading.
4. Handling of explosives.
5. Transferring of freight.
6. Checking of errors in loading and unloading.
7. Different systems of handling freight.
8. Cost of handling freight per ton, and how affected.

B.

1. Placing cars for loading and unloading. Importance of proper arrangement.
2. Carloads and less than carload lots, with special attention to loading cars to maximum capacity and the assigning of cars in commercial switching of such capacity as to nearly as possible fit the shipment offered.
3. Over and short shipments. How best avoided.
4. Sealing and seal records.
5. Routine, particularly of foreign cars.
6. Demurrage charges.

C.

1. Accounts and statistics. Make a careful study of all forms and reports and why used.
2. Filing of correspondence.
3. Classification of freight and tariffs. Note the difference between the Western and the Official Classification. These classifications should be studied with the view of learning how to find and apply rates.
4. Waybills and bills of lading.
5. Car records.
6. Loss and damage claims.
7. Per diem service rules.
8. Mail service.
9. Handling of train orders. (A general knowledge is all that is required at this time. Standard rules 201 to 223, inclusive, also 250 to 256, inclusive.)
10. Ticket sales.
11. Baggage and baggage records.
12. Soliciting business and representing company.

READING.

Yards and Terminals (Droege). Chapters 16 and 19.
Economics of Railroad Operation (Byers). Pages 513–536 and 194–209.
Railroad Organization and Working (Dewsnup). Pages 63–75, 113–126, 127–146, 443–440, 440–446, 447–458, 463–487.
American Railway Transportation (Johnson). Read the entire book, giving special attention to chapters 9, 10, 12, and 19.
Railway Mail Service (Tunnell).
Train rules, baggage rules, rule governing safe transportation of explosives.
Standard rules 916–963, inclusive.
Make a careful study of official time table.

ALLOTMENT OF TIME.

To subdivisions A and B, four months.
To subdivision C, two months.

SPECIAL NOTES.

1. Students must furnish satisfactory indemnity bond during time allotted to subdivision C. The premium on this bond will be paid by the company.

2. During this period too much emphasis can not be placed on accuracy of statement and courtesy in your dealings with the public. Bear in mind that you are a salesman, and that the success of your company depends very largely upon how you treat its customers. The public is not as well informed on railroading as you are, and apparently foolish questions are nevertheless honest. Give all the information and help you can.

3. Time is the essence of railroading. Have your switch lists ready for local crews doing waywork. Salaries and fuel consume money very rapidly, and ten or fifteen minutes' delay involves a great loss to the company.

Second Period—Nine Months.

Student in Maintenance-of-Way Service under Road Master and Resident Engineer.

A.

1. Roadbed: Width, cuts and fills, subgrade, ditches; method of forming embankments, culverts, drainage, destruction of weeds, fencing.

2. Ballast: Purpose, requirements, kinds of ballast and relative values; methods of laying, cost per cubic yard, and how affected.

3. Surfacing: Purpose, importance of not raising general level of track in surfacing; causes of center binding and springy track; how avoided.

4. Ties: Kinds; relative cost and durability; regulations for and methods of laying.

5. Tie renewals: Importance of this item and best method of determining when renewals should be made; cost.

6. Tie preservation: Methods of treating, cost of different methods, comparison of treated and untreated ties as to cost and durability.

7. Rails: Weight to be used and how determined; rail wear, on curves, on tangents, creeping; rail renewal, most effective organization of gang for this work; use of discarded rail; use of rail removed from main for side tracks; transferring inner and outer rail on curves.

8. Joints and joint fastenings: Relative merits of supported and suspended joints; comparative advantage of angle bars, 100 per cent, Bonzano, Weber, and continuous joints of various patterns; theoretical requirements for a perfect joint; cause of rail-joint failures, tamping of joints.

9. Switches and frogs: Split switch, Wharton switch, stub switch, elements of safety and danger in each; derailing switch and its uses; rules for laying switches. Frogs: give careful attention to the various designs for frogs, such as the spring-rail, stiff frog, and sliding-wing frog.

10. Tie plates: Advantages and different designs; merits of each.

11. Track implements: Proper care and record of same.

12. Buildings, bridges, track on bridge, trestles.

13. Wrecking and emergency work: Protection of trains, patroling of dangerous track, assembling material, organization of gangs, reports and records.

14. Compensation of grades, curvature, taper curves, super-elevations.

B.

Division engineer's office: Handling of material, distribution of forces, examination and study of reports, estimates for repairs and new work, accounts and records.

C.

Students will spend not less than two months in actual charge of a section gang, assume all responsibility ordinarily devolving upon a section foreman, and keep all records in connection therewith.

READING.

Economics of Railway Operation (Byers). Chapter 2, part 5.
Elements of Railroad Engineering (Raymond).
Railroad Construction (Webb). Chapters 1 to 12, inclusive.
Railway Organization and Working (Dewsnup). Pages 160–174.
Notes on Track (Camp).
Manual of Recommended Practice for Railway Engineers and Maintenance of Way.
Economics of Railroad Construction (Webb). Chapter 9.
Elements of Railroad Engineering (Raymond). Chapters 1 to 9, inclusive.

ALLOTMENT OF TIME.

To subdivision A, five months.
To subdivision B, two months.
To subdivision C, two months.

SPECIAL NOTES.

1. Tie renewals: This item is one of the most expensive in maintenance work. It will be found that section foremen, where the matter is left to their judgment, vary widely in the number of renewals made, even where the conditions obtaining are practically the same. A definite and well-carried-out system should be pursued in the matter of indicating when and what ties should be renewed, and should not be left to the chance judgment of individual foremen.

2. Very diligent study should be given to the methods employed during emergencies, such as washouts, slides, wrecks, etc. Above all things preserve discipline and organization. Do not give orders till you know the facts, and the best way to get facts is to get onto the ground, if possible, and learn them.

Third Period—Six Months.

Student in Master Mechanic's Office.

A.

1. Preparation and care of passenger cars.
2. Preparation and care of freight cars.
3. Car inspection, importance from standpoints of economy and safety, and with special attention to the relation of inspection to cost of repairs.
4. Rough handling and how best prevented.
5. Classification and construction of freight cars.

B.

1. Engines—Types and how classified.
2. Difference in design of various types of engines.
3. Purpose of different designs.

4. Repairs: Principal item in cost of repairs, cost per engine-mile.
5. Total cost of operating an engine per engine-mile. Elements which go to make up this cost and how affected.
6. Flange lubrication and results derived.
7. Fuel: Elements which determine the value of any given fuel; comparison of coal and oil.
8. Proper and improper use of fuel in firing and effect upon cost of repairs per engine-mile.
9. Water: Importance of good water. What constitutes good water.
10. Effect of poor water on cost of operation and repairs.
11. Methods of treating and economic results.
12. Pumping plants.

C.

1. Shops and roundhouses.
2. Organization of shop forces.
3. Distribution of labor.
4. Sources of expensive shop operations.
5. Distribution and care of supplies.
6. Importance of accurate checking of issues of supplies to engines other than water and fuel.
7. Careful study of the air brake.
8. Engine failures, causes and remedies.
9. Clerical organization.
10. Reports, statistics, and accounts.
11. Tonnage rating.
12. Effect of grades and curves on engine mileage and application of these factors to local tonnage rating.

READING.

New Catechism of the Steam Engine (Hawkins).
How to Run Engines and Boilers (Watson).
Elements of Railroad Engineering (Raymond). Chapters 11, 12, and 13.
Economics of Railroad Operation (Byers). Chapter 3, part 5, and pages 492–513.
Railway Organization and Working (Dewsnup). Pages 212–263.
Economics of Railroad Construction (Webb). Chapter 7.
Railroad Construction (Webb). Chapters 15 and 16.
Railroad Age Gazette, January 15, 1909, page 119.
Official Proceedings of Pittsburg Railway Club, January, 1908, page 94.
Standard Air-Brake Rules.
Locomotive Data (Baldwin Locomotive Works).

ALLOTMENT OF TIME.

To subdivision A, two months.
To subdivision B, two months.
To subdivision C, two months.

SPECIAL NOTES.

1. The subject of tonnage rating should be given very close consideration. It has been aptly said that the building up of a great railroad system depends on two things: First, loading cars; second, loading engines.

2. The student should obtain a fair working knowledge of elementary machine design, so as to enable him to read drawings of machinery without difficulty.

Fourth Period—Five Months.

Student Brakeman and Conductor.

[With regular crew.]

A.

1. Train signals.
2. Protection of trains.
3. Coupling and uncoupling, with attention to prevention of personal injuries.
4. Switching, with attention to prevention of personal injuries.
5. Handling cars, importance of careful handling.
6. Advantageous placing of cars in train.
7. Careful study of air-brake machinery and structure of cars.

B.

1. Way-freight work.
2. Handling of bills.
3. Conductor's records and reports.
4. Handling of train orders (to be studied from conductor's point of view).
5. Action in case of accidents.

READING.

Standard Book of Rules.
Current Time (Tanle).
Economics of Railroad Construction (Webb). Chapters 5, 10, 11, and 12.
Economics of Railway Operation (Byers). Chapter 4, part 5.
Railway Organization and Working (Dewsnup). Pages 243–263.
Air-Brake Catechism (Blackall).
American Railway Transportation (Johnson). Chapters 9 and 10.
Standard Air-Brake Rules.

ALLOTMENT OF TIME.

To subdivision A, four months.
To subdivision B, one month.

SPECIAL NOTES.

1. Students must pass a satisfactory examination on train rules by an authorized examiner before taking up the work of subdivision B.

2. Promptness and certainty in train movement is the essence of successful operation. Make every move count. One of the primary requisites for a successful railroad official is the ability to recognize when trains are properly and improperly handled.

Fifth Period—Two Months.

Student in Signal Engineer's Office.

BLOCK SIGNALING.

1. Manual block signals, staff system, telegraph system permissive, absolute.
2. Automatic block signals.
3. Interlocking plants, mechanical, electro-pneumatic, hydropneumatic, all-air, all-electric.
4. On single track; on double track.
5. Protection of crossings.
6. Mechanism, maintenance, installation.
7. Cost of maintenance, accounts and records.

READING.

Elements of Railroad Engineering (Raymond). Chapter 10.
Railroad Construction (Webb). Chapter 14.
Block System (Adams).
Railway Organization and Working (Dewsnup). Pages 160-211.
Standard Book of Rules.
For definitions and illustrations, see Signal Directory, 1908 edition.

Sixth Period—Two Months.

Student in Store Department.

1. Careful study of uses, value, and proper care of company material. This information to be gained as helper to section storekeeper in general store.
2. Handling of requisitions; necessary approvals; from what data prepared; method by which stock is made available quickly.
3. Pricing; distribution of charges to various accounts; analysis and purpose of statements in connection with stores department.

READING.

Railway Organization and Working (Dewsnup). Pages 141-159.
Elements of Railroad Engineering (Raymond). Pages 1-16.
Economics of Railroad Construction (Webb). Chapters 1 to 5, inclusive.
Economics of Railway Operation (Byers). Chapter 6, part 5.

SPECIAL NOTE.

Special attention to be given to the manner in which material is assembled and distributed during emergencies.

Carefully note total amount of stock and material carried and its effect on economical operation. How it can best be reduced to minimum and fill orders promptly.

Seventh Period—Four Months.

Student in Accounting Department.

1. Daily report of movement of trains.
2. Statement of gross and net tons hauled in freight and mixed trains.
3. Locomotive performance in freight service.
4. Statistics of freight-train service.
5. Statistics of passenger-train service.
6. Operating statistics, by divisions.
7. Operation of important freight stations.
8. Statistics of maintenance of way and structures.
9. Statement of revenues and expenses.
10. Railroad organization.

READING.

Economics of Railway Operation (Byers). Parts 1, 2, 3, and 4.
Railway Organization and Working (Dewsnup). Pages 1-36, 44-62, 141-146, 264-384.
Elements of Railroad Engineering (Raymond). Pages 1-16.
Economics of Railroad Construction (Webb). Chapters 1, 2, 3, and 6.
American Railway Transportation (Johnson). Chapters 5, 6, 7, 8, 13, 14, 25, 26, 27, 28, and 29.
The Railway Auditor (Whitehead).
Anatomy of a Railroad Report and Ton-Mile Cost (Woodlock).
Accounting System Required by Interstate Commerce Commission.

SPECIAL NOTE.

The chief value of statements rendered operating officials lies not in their forming a condensed compendium to which reference may be had to ascertain the total expenditures and receipts governing any given item, but in affording a panoramic view of the entire situation. These statements are the mountain tops upon which the general may stand and study in perspective the movements of his army below. In the thick of the fight, that with which he is in immediate contact is likely to assume, to him, undue proportions at the expense of other things which are of vital importance.

The failure of many a good man is directly traceable to the fact that either through indifference, or lack of ability to do so, he did not properly analyze and interpret statements from the accounting department.

Eighth Period—Eight Months.

Student with Train Master.

A.

With yard master:

1. Make-up of yard; purposes and uses of several groups of tracks.
2. Switching.
3. Weighing.
4. Make-up of trains: First, as to safety; second, as to destination; third, as to contents.
5. Necessity for care in handling cars.
6. Causes for unnecessary switching, and how avoided.
7. Loading of engines to full tonnage rating.
8. Special attention to methods of clearing blockades.
9. Yard master's records.
10. Yard expenses per freight car handled; how affected.

B.

With dispatcher:

1. Systems of dispatching: Double order; telephone A. B. C., and staff system, and relative merits of each.
2. Different forms of train orders and their uses.
3. Handling trains, importance of economy of time in making meets.
4. Importance of familiarity with length of sidings, grades, etc.
5. Knowledge of capacity of engines. Effect of train resistance.
6. Chief causes of delays, and various methods of overcoming same.
7. Work on time-table. Charts.
8. Balancing of traffic.
9. Dispatcher's records and reports.

C.

With train master:

1. Expedition of car movements, and distribution.
2. Handling of fast and slow freight, with reference to necessity and competition.
3. Full loading of cars and engines.
4. Education of station agents in the matter of full loading of cars, prevention of delays, maintenance of neat yards and stations.
5. Cutting down of overtime. How best accomplished.
6. Balancing of way work between crews.
7. Investigation of delays.
8. Enforcing operating rules.

9. Wrecking work.
10. Carrying out of the division's policy.
11. Disciplining of employees.

READING.

Standard Book of Rules, in its entirety.
All wage schedules and agreements between company and employees.
Yard and Yard Terminals (Droege).
Elements of Railroad Engineering (Raymond). All portions relative to economics of railroad operation not previously assigned.
Economics of Railway Operation (Byers). All portions not previously assigned.
Railway Organization and Working (Dewsnup). All portions not previously assigned.
Letters of an Old Railroad Official to His Son, a Division Superintendent (Hine).

ALLOTMENT OF TIME.

To subdivision A, two months.
To subdivision B, two months.
To subdivision C, four months.

SPECIAL NOTES.

1. After the completion of this period the student will be placed wherever it may appear necessary, in the judgment of the management, to give him further instruction in order to prepare him for promotion to a permanent position.

2. Special attention should be given at all times to the diplomatic handling of men. Men will have all sorts of grievances, real and imaginary, and it makes no difference how thorough a knowledge you may have of a subject, unless you are able to maintain pleasant relations with the men under you and still be absolutely fair and impartial, you are a failure.

3. Keep posted as to actions taken by officials in cases of emergency, accidents, and the like. There is nothing more important than quick and considerate action in cases of emergency; the proper care of passengers in accidents. The public will not be charitable toward your shortcomings, and it will many times occur that upon a single act of yours at the time of an accident the entire management of the road will be praised or condemned. Earn and keep the good will of the public by giving every assistance you can consistently.

SPECIAL APPRENTICESHIP ON THE METROPOLITAN STREET RAILWAY (NEW YORK CITY).

The Metropolitan Street Railway of New York City is not on the basis of steam practice, but its operations are so large and the interurban electrics are so closely related to steam practice that their undertakings belong within the scope of this study. In July, 1909, the general manager announced a new plan of special apprenticeships. Electrical railroading has developed so greatly within a few years, and is still expanding so rapidly, that companies are handicapped by a dearth of men with the right kind of training.

The announcement of the general manager, Oren Root, is as follows:

It is my intention to establish a practical training school for young men, particularly graduates of high schools, manual training schools, colleges, or universities, who have had more or less technical training and who intend to enter upon the vocation of operating street railroads.

If, after two years of satisfactory work in the Metropolitan Street Railway School, a young man for some reason is not retained, he will be given a certificate which, it is believed, will enable him to find employment without difficulty with some other traction company, and will give him special advantages in rising in this very important branch of industry.

It is the aim to make the conditions advantageous to the young man who has an inclination to enter upon work of this character, but who, from lack of knowledge of practical conditions, does not feel able to make a definite decision. Such a man, under the proposed plan, will be afforded an opportunity to acquaint himself with the details of this work, and at the same time will receive a salary which, with strict economy, will enable him to be self-supporting. He may thus determine for himself whether he is fitted and has a liking for employment of this character. On the other hand, the Metropolitan Street Railway Company will profit by the experiment in that it will be possible to test the capacity, ability, and adaptability of young men who will constitute a body of candidates for vacancies on the regular operating staff.

During the first year the student will be paid at the rate of $15 a week. In order to give him a general idea of the railroad system, he will be assigned to duty in the maintenance-of-way, the electrical, the equipment, and the transportation departments, spending three months in each department.

Maintenance-of-Way Department.

Students will be assigned to field work in connection with the renewal of rails and installation of special track work in the streets, involving all of the various features which enter into this situation, such as the efficient and economical handling of men, the performance of tasks with a minimum amount of delay to car and street traffic, the laying of asphalt and other pavement, and similar work. Assignments will be made to other engineering work, such as the making of surveys, designing of special track work, compilation of estimates of cost, designing and construction of buildings, problems incidental to fireproof car-house construction, and miscellaneous matters such as distribution of charges and time keeping.

Electrical Department.

During his three months tour of duty in this department the student will be given an opportunity to familiarize himself with the conduit and feeder system; that is, the location and character of the various cables, both high and low tension, by means of which the electrical energy is transmitted from the power station to the cars on the street. Questions involving the maintenance of this complicated system will be presented to the student. He will have an opportunity of observing the practical measures adopted to overcome difficulties incident to the work. He will also receive experience in electrical and steam engineering in the power house where alternating current is generated at a high voltage and in the substations where the current received from the power station is reduced to low voltage and converted into direct current. Special assignments will be made to the students from time to time to ascertain the ability and capacity of these men.

Equipment Department.

While working in this department the student will be given duties in the car houses and in the repair shops. He will become acquainted with the practical difficulties incident to the maintenance of car equipment under operating conditions and the methods followed in making minor repairs, as well as the more comprehensive overhauling—such as the rewinding of armatures, repairing of commutators, and the replacing of fields. The student will also obtain some machine-shop experience, covering blacksmithing, lathe turning, and metal work in general.

Transportation Department.

Upon entering this department, the student will be assigned to the school for motormen, where he will learn to operate a car, as well as become familiar with the function of each part of its mechanism. Subsequently, he will be assigned to duty as a conductor or motorman for a short period. Following this experience, he will be given a thorough course of instruction by the officials of the transportation department, and thus become acquainted with the details of regulating the service under normal conditions and in emergencies. A certain period of time will also be devoted to learning routine work in the division offices. The student will be assigned to special work from time to time for the purpose of testing his powers of observation, analysis, and deduction.

It is expected that the membership in this school will be limited to approximately eight men at any one time, thus involving an assignment of two such men to each of the departments during each three months' period. Those who prove incompetent will be dropped, but those who complete the first year of apprenticeship will be definitely assigned to that department for the performance of the duties of which they have manifested the greatest ability, and, dating from the time of appointment, they will be paid at the rate of $20 per week.

It should be understood by men who think they would like to take advantage of this opportunity that their tasks will often involve night and Sunday work. It is not recommended that any man should apply for such a position as above described unless he is strong physically and is prepared to perform hard work.

In considering applications, preference will be given to men who have received a technical education, including such courses as electrical or mechanical engineering, as a knowledge of such subjects will be of material advantage to the student. The lack of such a training, however, will not preclude the consideration of an application, nor will it necessarily militate against the success of the student in departments of the company where this technical training is not indispensable. Applications will be received from men who have been out of school or college for several years, as well as from men to be graduated this year.

VII. THE SCHOOL—ITS FUNCTIONS AND METHODS.

Viewed broadly, railroad education, as the process of acquiring fitness for railroad work, is at present carried on in three general ways:

(1) Experience by actual work, where there is nothing more formal than general lines of promotion, and the discipline that is made to apply in each position.

(2) The apprenticeship, giving only casual instruction and selected sequence of experience.

(3) The school, giving formal instruction.

We shall consider in the following pages the various characteristics of the last named of these educational agencies.

The primary distinction of a school of any kind is that the thing to be produced is the fitted man. If in the process of his education any work is done or any other value is produced, it is a by-product of the main result—the fitted man. Possibly it may be required that the

work done by the student shall be commercial, but this is merely a device to train the man more efficiently to a certain, self-reliant work sense.

Education, experience, fitness are each, at the last, power—power to do, power to adjust one's self to the environment so as to be efficient, to have mastery. For this, one must identify the miscellaneous facts of experience and classify them, in order to express them in general terms that shall serve to exhibit them in their subsequent recurrence. Such an identification and location of facts of previous experience facilitates that personal adjustment which is power. These group concepts by which the classifications are made are our working tools. Every man has them, every man must have them. Among different trades and professions they are different combinations from the same set of phenomena, and among men of different degrees of ability they are different ranges of classification or generalization.

Each fitness to be acquired works out its special economy from the same array of objective facts. General practice in a trade, a "school" of thought or work, or a profession, has evolved those group concepts—those systems of classification which the body of experience justifies, and the knowledge of them and power to adjust one's self to them constitutes skill. Such a result is reached by a process of elimination and selection. The trade or profession, in its evolution, covered the ground by processes so slow that no individual life could embrace them in its span. The individual, therefore, is instructed from the experience of others, and the results of this experience are handed over to him ready-made, as it were, into definition of words, supporting formulæ, characterizing sense-knowledge. This is instruction pure and simple. It is intended to be a labor-saving, time-saving, resource-saving device. It is the method of the school, but there have been failures in its application. The difficulty has arisen in the terms in which these results of experience were expressed and transmitted. The first communicable definition of anything is in words. But words are merely a vehicle by which one man undertakes to carry his experience to another. They never can tell more than a very small part of that experience, and the amount they tell in individual cases will greatly vary with the receptivity of individuals.

This is especially made obvious by the failure of well-meant efforts to instruct the rank and file of men by the university method of lectures. That facility, either of reducing their own experience to the terms of words, or of understanding the experience of others when expressed in words, is very defective in the great body of men. Train masters who drill their men in the mere recital of train rules are sometimes rudely awakened to how little meaning mere words convey to certain orders of intelligence. It is at this point that much differ-

ence of opinion and practice arises. The school seeks to modify this limitation by giving samples, as it were, of the general principle by means of sense knowledge—in short dashes of actual experience. It may adopt the inductive method entirely, setting out the order of experience on the one hand, and, on the other hand, assisting the learner in drawing up the inductions. But this process is still instruction, in so far as it is the interposition of an outside intelligence to set out and enhance the processes of experience. Courses are sometimes laid out which are comparable to the accelerated tests of the technological laboratory. The schedule of instruction, like the accelerated test, may leave out some essential factor and include some nonessential factor, or some factor in undue proportion. It frequently errs in being too orderly. A large part of the education of experience is what is learned by failures. The effort to avoid repetition of failure throws the worker into a practical mental attitude toward the object to be attained, which can not be expressed by formula. This is a mental attitude that makes for resourcefulness and initiative.

But with all these limitations, the school is the modern method of acquiring fitness as the railroad is the modern method of carrying freight. The fault is not with the principle but with its application. A vital factor for success or failure lies at the point where the learner is absorbed into the working body. Instruction, as we have seen, is the tool by which fitness is most quickly and easily acquired, and the school is the factory where are gathered all the latest labor-saving devices known to the educator.

The various schools which do work in any way bearing on the special fitness for railroad service are the vocational railroad school, the high school (continuation school), the correspondence school; and in higher education the technical school, the railroad engineering school, the school of railroad engineering and administration, and the school of railroad administration.

VIII. VOCATIONAL RAILROAD SCHOOLS.

By a vocational railroad school we would mean a school, as distinguished from an apprenticeship, where the students are under instructors, and where they are trained to a specific fitness for one particular phase of the railroad service. Such schools begin with a common school educational requirement, which is also the starting point of a high school course, but they are strictly vocational, and extend over only so much time as may be necessary to acquire the specific skill for which they train. Some of them are only three months' courses, and they seldom extend over two years. The work may be done at night—in which case the course is somewhat analogous

to the continuation schools abroad—or it may require the full time of the student.

There have been few instances of vocational railroad schools in the United States, except in the mechanical department, where they are a part of regular apprenticeship. So far, there is only a limited number of fields in which it has been conceded that students could be trained for regular railroad work by the methods of the school, and the school idea, therefore, when adopted, has been made to serve largely as a recruiting bureau.

One of the classes of skill requisite in railroad service, and which can be acquired outside of the service, is that of telegraphy.

ELMIRA SCHOOL OF TELEGRAPHY.

On the line of the Erie Railroad at Elmira, N. Y., is a railroad commercial-training school which is on a more substantial basis than any other. The idea originated with President Underwood of the Erie, and he has lent his active cooperation. The work is under two former railroad men, the one a chief dispatcher and the other a chief clerk at a station. The effort is to train telegraphers and station agents. Each student is under individual instruction, so that the school period depends on himself, but normally it should cover six months. The entrance requirements are good hearing, good eyesight, and other physical tests, a common-school education, and plain handwriting. The age limits are 17 and 25. Both girls and boys are admitted, and a position is guaranteed on graduation. The semiofficial character of the school makes this assurance possible. Graduates are at once installed as helpers at local stations. The work done is set out with fidelity in the prospectus, from which we make the following excerpts:

COURSE OF TRAINING.

A student upon enrollment is started in the beginners' room, is given the Morse code to learn, the correct manner of handling the key, and the formation of characters with it. Close personal attention is given to the beginner, and he is soon impressed with the knowledge that there is as much character in an operator's "Morse" as there is in a man's penmanship, and that to enable an operator to take his messages the characters must all be made correctly. When the student can send and receive with a perfect understanding of what is right or wrong in his practice, he is ready to advance to the intermediate room, where he is put upon a regular circuit and commences handling messages and train orders as sent and received by the instructor or other students of the same grade. He also has the main-line railroad wire to receive from while in this room. As soon as the students are able to catch a few letters or words from the main-line railroad wire, they are advanced to the graduating room, where they are thoroughly drilled in freight accounts, telegraphy, how to patch wires, locate breaks on telegraph lines, etc., by use of the switchboard. Students in the graduating room also receive instructions in the demonstrating room, which is unique, there being none other like it in the United States. At one end is a standard-tower equipment, 12-lever interlocking plant for operating signals and switches; at a con-

venient distance is a full-sized interlocking switch of 60-pound rail laid on ties, representing a main track and passing siding, also six full-sized block and dwarf signals (equipped with lamps) governing same, operated same as an interlocking plant on the railroad. In the same room is the train dispatchers' office, supplied with train sheets, train-order books, time-tables, etc. Opposite the train dispatchers' office is the ticket office, in which is a standard ticket case fully equipped with local and interline tickets, daters for stamping tickets, and the different punches used by the agent. There are four block-signal stations on our railroad; each station is equipped with telegraph instruments, bells, switchboards, train-order forms, block records, time-tables, etc. Each station and the dispatchers' office is connected by telegraph line running alongside the railroad on poles, over which all train orders are sent. Our railroad is a double-track road; trains are run, towers, block signals, and switches are in operation. The motive power used is electricity. All work given in this room is the same as that given on a trunk line. All students are thoroughly instructed in every branch of the work, so that when they leave the school and take up the positions that always await them, they know what is expected from the start.

TRAFFIC DEPARTMENT.

Owing to the fact that we are a railroad school and indorsed by railroad officials, the material used for instruction purposes allows us to give our students a very comprehensive course, taking the student by gradual steps from the simplest form of railway and commercial transaction to the most complex. In progressing he will receive full instructions from the time freight is received from the consignor at the receiving station until it reaches its destination and is delivered to and receipted for by the consignee. In the course of transit from the forwarding to the receiving station, he will be drilled in the use of the more prominent blanks, shipping order, bill of lading, waybill, freight bill, and delivery receipts, correction notices, over, short and damage, etc. He will also be carefully instructed in station accounts, daily cash record, freight received record, monthly cashbook, ticket book, remittances, etc., and the forwarding of daily, weekly and monthly reports to the various departments, in all of these transactions using the same blanks that are used in the actual dispatch of business on the principal railways.

TICKET SELLING.

In ticket selling the work is equally as practical, tickets being sold and payments made in school money.

The student is carefully instructed in regard to the various kinds of tickets used, how ordered, entry on stock book, method of keeping account of tickets sold, transfer of amount of daily sales to monthly cashbook, etc., as well as in relation to the rules, regulations, and methods of handling baggage, making reports, etc. In fact, this course of instruction, having been prepared by practical experts in accounting, traffic, and operating departments, every step and detail has been carefully considered and covered in the plainest and most comprehensive manner in our plan of education, and the student will enter actual service as soon as he graduates, without having to go into a railroad office to learn the business and "get experience," as is required in the case of some of the students turned out by so-called "railway schools."

The school uses a text-book of its own compilation designed to instruct in the duties of a station agent. This book begins with a cursory glance at the history and general public character of railroads and their system of organization. It gives a general description of the station agent, and then follows a series of numbered paragraphs

to the extent of some 130 pages, describing his duties in detail. This text is in the form of the books of instruction issued on many roads which the agents are left to master in their own way.

The school has been in operation for three years, and the statistics to date are as follows:

Enrolled February 28, 1909	43
In Erie service	59
In service of foreign roads	29
Left before completing course	42
Left railroad after being placed	24
Total	197

The tuition is $6 per month, or $30 for the full course, including all stationery and text-books. Regular school hours are enforced: 8.30 a. m. to 12 m. and 1.30 to 5 p. m., every day except Saturday afternoon and Sunday. With 80 scholars this school is self-supporting.

RAILROAD Y. M. C. A. COURSES.

The Young Men's Christian Association has steadily widened the scope of its activities from religious and welfare work purely into the field of education and has now come to provide a machinery of courses, curricula, instructors, text and reference books, standard requirements of completed courses, and certificates or diplomas having fairly definite value. This machinery is offered wherever there are large bodies of men, and it has been turned to account extensively by railroad companies. The vocational railroad work there done differs from that of the vocational schools mentioned above, because it is intended for those already in the employ of the railroad. The work is largely designed to meet the requirements of train and shop men, and when used it serves as an effective adjunct to the administrative machinery of the transportation and mechanical departments. The courses are short and the work is a natural extension of the railroad club idea. Thus a popular method is to form groups of men for six weeks or season courses in such railroad subjects as locomotive and car design, boiler firing, locomotive engineering, and special courses for enginemen, locomotive firemen, conductors, trainmen, office men, and in the handling of air brakes, the transportation of explosives, etc. In this form the courses take on the character of institutes, the work being carried on by lecture and demonstration.

The vocational railroad school independent of an apprenticeship and for the ordinary employee has so far not been seriously carried out on any railroad, barring only the Altoona High School, where the Pennsylvania Railroad has undertaken to turn the high school course into a vocational railroad course for the mechanical depart-

ment. This Altoona High School course is described under "High schools."

The serious vocational training of the ordinary railroad employee in other departments than the mechanical is to-day a vital need on American railroads. It can not come, however, until the railroads recognize training-school methods as a fixed adjunct to their administrative machinery—providing skilled labor and maintaining and enhancing its standard of efficiency. This recognition must be in the form of credit for work done in such training schools, and also in greater freedom of movement for employees to and from the schools among the departments and through the several grades of the service, according to their actual fitness.

W. G. BERG ON SECONDARY VOCATIONAL RAILROAD SCHOOLS.

The great advocate of the secondary vocational railroad training school was Mr. Walter G. Berg, formerly chief engineer of the Lehigh Valley Railroad. His appreciative insight into the needs at this point made him a recognized authority on the subject. The programme which he laid out was so thoroughly informed of the conditions it was designed to meet that it offers to-day—nearly ten years after its publication—the best working plan and curriculum of which the writer has knowledge.[a] We give it below because it is a carefully studied suggestion of the lines on which this need must be met.

PROGRAMME FOR A SPECIAL RAILROAD TRADE SCHOOL.

The institution should be conducted according to the spirit and on the basis of a trade school, not of a college. Its success will lie in doing its work thoroughly within its proper sphere and limits, without making a display of its great learning or advertising its workshop system as a leading feature.

The entrance requirements would be limited to a general common school education, more or less advanced, according to which department the applicant desired to enter.

The school would consist of a regular course of one year and of an advanced course of one year; also a general course.

The scholars for the regular course would be young boys direct from public school and young men who, after a few years' work in a shop, office, store, or railroad department, begin to realize that their rapid success in life may depend largely on a better general knowledge of and familiarity with one subject or some specialty.

The advanced course would be open to such scholars who had completed the regular course and whose means and abilities enabled them to pursue their special studies to a higher point. Also, men whose former education and subsequent railroad experience would qualify them to omit the regular course.

The general course, consisting of lectures on general railroad subjects, would be open to all comers, in order to spread a better knowledge of the general conditions, laws, and public policy governing railroads among the general public.

[a] This was reprinted entire in the monograph, Educational Training for Railway Service, published in the Report of the Commissioner of Education for 1899-00.

The studies in the regular course would be so arranged that the course in itself would be complete from a practical view; that is, giving the scholar a general idea of the subjects taken up, the elementary principles governing his selected calling, and acquaintance with the principal details. Practical railroaders could attend this course without fear that the matter presented would be too high or extended for their purposes. The course would be divided into two terms, and the studies of the first term would be common for many scholars, who would then in the second term branch off to their chosen specialties.

In the advanced course the fundamental idea would be to build upon the general basis established by the regular course; to extend the different subjects to a higher grade, treating them in a more thorough and scientific manner; and to afford more time and opportunities for illustrative examples, demonstrations, laboratory, workshop, and drawing-room exercises.

The general course would consist of evening lectures at stated intervals on the most general laws and conditions governing the control, operation, and management of carrying companies, their relations to the state authorities and the public at large, their history and influence in industrial, trade, and labor questions.

All illustrations, examples, demonstrations, laboratory and workshop exercises would be taken from appropriate practical problems and conditions connected with railroad work. The workshop feature should be considered as an important adjunct to the lessons, illustrating in a practical way the principles and methods developed and explained in the schoolroom. Any suggestion that regular skilled workmen could be turned out of school workshops should be promptly discountenanced.

The choice of the teachers and managers would be most important. For many of the branches theoretically educated men, with a subsequent long practical experience in their particular line, would be most desirable. In other branches experienced railroaders would be preferable, who, in spite of the neglect of their early education, had by innate common sense, observation, and study in later life become masters of all the questions connected with their branch of work. A European element should be strictly avoided, and knowledge of the actual wofking and status of the conditions existing on American railroads be absolutely requisite. The salaries offered should be such as to induce practical men, whose standing in the railroad service is well known, to relinquish their positions and devote their talent and energy to the furtherance of the school as a life object.

The special departments or groups of railroad callings for which provision should be made are about as follows: Accounting and auditing, general railroad appliances and supply business, traffic, transportation and operation, telegraphy and signals, motive power and mechanical, car building, construction and roadway, buildings, bridges.

The studies for each group would be similar to the programme outlined below, which is not claimed to be final, but simply indicative of the general character, trend, and scope of the work for each particular department. Many of the studies would be taken up in joint classes by the scholars from several departments; other studies are special for the individual department.

Accounting and auditing department.—Regular course, first term: Elementary bookkeeping; railroad department reports, material accounts, pay rolls, time distributions, recapitulations; general description of railroads, their equipment and management. Second term: Double-entry bookkeeping; supply and shop accounts; balance, performance, and mileage sheets; elementary business law. Advanced course: General railroad accounts for revenue and disbursements; auditing and collection systems; general balance sheets, reports, and statistics; stocks and bonds; mortgages and securities; trust and construction companies; law and general policy of accounting and auditing questions.

General railroad appliances and supply business department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; general description of railroad appliances; properties of materials. Second term: Railroad supplies and their properties; quality, elementary, physical, and chemical tests; detail examination of railroad appliances; special instruction for tie, lumber, rail, iron and steel inspectors; storehouse systems. Advanced course: Chemistry and physics in connection with examination of materials; chemical and physical examination of railroad supplies, materials, and preservatives; independent laboratory and shop experiments; general industrial technology and metallurgy; description of important industries and trades producing railroad materials.

Traffic department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; freight, passenger, baggage, express, and mail service; duties of freight and ticket agents, baggagemen, and expressmen; local, terminal, and transfer stations; forwarding offices. Second term: Double-entry bookkeeping; accounting systems in passenger and freight business; freight classifications and rates; clearing houses and car-record systems; elements of law. Advanced course: Preparation of rate sheets and freight classifications in regard to special conditions; special rates and drawbacks; freight lines; pooling systems; foreign freight systems; general principles governing passenger business; the law and general principles governing all traffic questions; history of traffic and transportation lines; the proper relations between legislative bodies, state railroad commissions, and railroads in regard to traffic business.

Transportation and operating department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; duties of conductors, brakemen, switchmen, yardmasters, inspectors, repair men, station masters, dispatchers; movement of heavy bodies and hoisting machinery, clearing wrecks; train service; general description of railroad appliances. Second term: Train orders and regulations; dispatcher's duties and authority; preparation of time-tables; detail description and illustration of railroads, their equipment and management; car records, mileage, and performance sheets. Advanced course: General administration of railroads in relation to condition of road, equipment, and trade; economy in train service and equipment; influence of grades and curves; quality and capacity of rolling stock and general principles governing its use and construction; examination of advanced methods and improvements; special railroad appliances and inventions; the law governing train service, road and grade crossings, corporate property, liabilities for damages, etc.; history of transportation and traffic lines.

Telegraphy and signal department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; elements of telegraphy, with practice in use of instruments; duties of operators, linemen, repair men, etc.; with appliances and methods in use; details of signal apparatus and methods in general use; construction and repairs of instruments and signal apparatus; general description of railroads, their equipment and management. Second term: Practice in rapid transmission of messages and use of complicated instruments; train dispatching; elementary science of telegraphy and elements of chemistry; descriptions and applications of electricity to special purposes, as alarms, tickers, telephone, automatic recorders, electric light, etc.; complicated signal systems, their use, construction, and repair. Advanced course: Practice in the use of complicated telegraph methods employed at central stations and on heavy lines; submarine telegraphy; application of electricity to complicated and delicate machines for recording tests, measuring time, etc.; electricity as a scientific subject, with experiments and laboratory exercises; detail his-

tory of electrical inventions and methods, with careful examination of instruments and specific features of each method; electrical engineering and construction of telegraph lines and electrical machines; electrical mechanics; physical and chemical properties of electrical materials; electricity as applied to railroad signals; railroad signals as a general study in connection with history and detail of foreign railroad signal systems; the law governing inventions; mechanical and free-hand drawing.

Motive power and mechanical department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; practical mechanics; movement of heavy bodies and hoisting machinery, clearing wrecks; properties of materials; general description of machinery and locomotives, with distinguishing features and nomenclature of parts; duties of engineers, firemen, engine-house men and foremen, road foremen of locomotives, car inspectors; mechanical and free-hand drawing. Second term: Elements of theoretical mechanics and physics; practical mechanics; details of locomotives, their use, construction, and repair; elementary theory of the steam engine; general shop machinery, its construction and uses; railroad orders and regulations; designing locomotive and machine details; mechanical and free-hand drawing; railroad appliances and supplies used in rolling stock and shops. Advanced course: Theory of machinery; theoretical mechanics and physics; the general principles and rules governing the construction and use of locomotives and rolling stock; machine design and economy; general machinery; construction and setting of stationary machines; transmission of power; locomotive designs and construction; mechanical and free-hand drawing and coloring.

Car-building department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; practical mechanics; movement of heavy bodies and hoisting machinery, clearing wrecks; properties of materials; general description of car-building machinery and rolling stock, with distinguishing features and nomenclature of parts; duties of various car-shop mechanics, foremen, car inspectors; mechanical and free-hand drawing. Second term: Elements of theoretical mechanics and physics; practical mechanics; details of cars, their use, construction, and repair; general shop machinery, its construction and uses; railroad orders and regulations; designing car and machine details; mechanical and free-hand drawing; painting and painters' supplies; railroad appliances and supplies used in rolling stock and shops. Advanced course: Theoretical mechanics and physics; calculation of strength for minor parts; the general principles and rules governing the construction and use of cars and rolling stock; machine design and economy; general machinery; car designs and construction; mechanical and free-hand drawing and coloring; artistic ornamentation and designing.

Department of buildings.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; practical mechanics; movement of heavy bodies and hoisting machinery, clearing wrecks; properties of materials; building mechanics and building trades; general description of railroad buildings and structures, with illustrations; mechanical and free-hand drawing. Second term: Structural details; bills of material, estimates; designing details; manufacture of building materials; laying off work; erection of buildings and structures; building laws; elements of theoretical mechanics and physics; ornamental work and designs; mechanical and free-hand drawing. Advanced course: General construction and details of railroad buildings and structures; calculation of strength for minor parts; the chemical and physical properties of building materials for strength, durability, inspection, and testing purposes; theory of hoisting machinery; artistic ornamentation; designing; free-hand drawing and coloring.

Department of bridges.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; practical mechanics; movement of heavy bodies and hoisting machinery, clearing wrecks; properties of materials; general description of bridges and trestles, with illustrations; mechanical and free-hand drawing. Second term: Wooden and iron bridge details; bills of material, estimates of weight; designing details; manufacture of iron and steel; shopwork on bridges; erection of bridges; tests of materials; elements of theoretical mechanics and physics; special machinery and appliances for moving heavy bridges; mechanical and free-hand drawing. Advanced course: General construction of bridges and details; theoretical mechanics applied to calculation of minor structures for strength and material distribution; the chemical and physical properties of bridge materials; the duties of bridge foremen and inspectors; maintenance of bridges; complicated bridge erection; theory of hoisting machinery; designing; history of bridge constructions.

Construction and roadway department.—Regular course, first term: Elementary bookkeeping; department reports and accounts; general description of railroads, their equipment and management; practical mechanics; movement of heavy bodies and hoisting machinery, clearing wrecks; properties of materials; duties of section men and supervisors, and means and methods at their command; description of track material and implements, with their use; mechanical and free-hand drawing. Second term: Construction of roadbed; laying tracks; maintenance of way; grading and masonry, with tools, methods and designs in use; explosives and their use; staking out work; laying off frogs, switches, yards and track systems; grades and curves; general regulations and orders; special machinery and appliances for clearing heavy wrecks. Advanced course: Grade lines and curves in reference to rolling stock and operation of the road; details and designs for frogs, switches, yard systems, crossings, signals, and gates; complicated track systems and methods of shortening up leads; designs for culverts and masonry structures; economy in grading and track work; tunnel work, methods and appliances; rock machinery and properties of high explosives.

General course.—The general course would take up in a general and popular manner general railroad law covering the rules governing corporations and their financial affairs, their obligations and privileges as common carriers, railroad legislation and state control, corporate property; the law and principles of transportation, traffic, and train service; railroad securities; history of railroad inventions and patent law; history of railroads and transportation service; the conflict between labor and capital; trade and commerce in its relation to railroads and the prosperity of the country, etc. The number of subjects that could be embraced in the general course is very large, the above list being only indicative of its general character. This general course is susceptible of being greatly extended so as to include series of popular lectures by the most eminent men of the country on questions pertaining to railroads and corporations, and to form the nucleus of an association for mutual improvement and for the promotion of a better public understanding of general railroad questions, with publications, prize problems, essays, etc.

The success of any railroad vocational school depends very largely on the way its course is grafted into the railroad service. If the raw boy is left to grope his way from the schoolroom to the railroad and coordinate the theory of the one with the haphazard practice of the other, the results will be disappointing. The stake renders it important that railroads should provide an apprenticeship designed to definitely take over such boys into the service.

IX. HIGH SCHOOLS.

Except in a few cases there does not seem to be a sharp line of distinction made by railroads between the applicant having a common-school education only and the applicant having a high-school education. These exceptions, however, appear sometimes in the accounting department; as on the Maine Central and on the Buffalo, Rochester and Pittsburgh railroads, where the preference is given to applicants with a high-school education.

In the shop work, a few roads—as the Baltimore and Ohio Railroad—have a special class of apprenticeship for high-school graduates. For the most part, such distinctions as are made are primarily a recognition of the greater maturity of the high-school graduate (three to four years older than the common-school graduate) and presumed better mental discipline. The value of the manual training offered by the high schools so far is commented on variously by the railroads as disciplinary, but it is not carried over into the service at a definite valuation.

The lack of cooperation between the high school and the railroad is a serious matter. The railroad fails to recognize the possibilities for its service in a high-school course shaped somewhat to its needs, and the high school does not deliver a boy with any specialized fitness. The want of cooperation between the high school and the railroads is a serious loss to both. This cooperation would be advantageous in the commercial high school as well as in the manual training and technical courses. Unfortunately the lack of flexibility in many railroad organizations renders clerical positions unattractive. The principal of a commercial high school in one of the largest railroad centers writes:

> Our best men shun such positions, or if they get into them, they become dissatisfied and leave. The railroad clerkship offers to the mediocre, easy going, nonambitious fellows a comfortable berth, tolerably short hours, certain though slow promotions; to the energetic fellows there seems to be little in prospect in such positions. Naturally, we make little special effort to train men for railroad positions.

From the employer's viewpoint, an official of the Baldwin Locomotive Works—whose requirements are largely parallel to those of the mechanical department on a railroad—writes:

> We do not regard manual training in public high schools as being of special value to boys coming to us, and we place such students upon precisely the same basis as those from other schools without manual-training courses. I do not see how a cooperative agreement between schools and shops could be practicable.

THE FITCHBURG (MASS.) SCHOOL-SHOP COOPERATIVE PLAN.

As opposed to the views of the employer just quoted, there is now in force at Fitchburg, Mass., such a plan of cooperation between the shop and public high school, which has proved highly practical and

satisfactory. We quote from the annual report of Superintendent Edgerly:

The basis of the plan is the alternating of shop work and school work. The boys who elect this course receive instruction in the shop during one week, and instruction in the school the next week. The contemplated course is of four years' duration. The first year is spent wholly in school, and during the other three years the boys alternate weekly between school and shop.

Any boy who is regularly admitted to the high school may, with the approval of his parents, elect this course.

The manufacturers take the boys in pairs, so that by alternating they have, at all times, one of the pair at work. Each Saturday, at 11 o'clock, the boy who has been at school that week goes to the shop and learns on what particular job his alternate has been working and how it has been handled, in order that the work may be taken up without delay the next Monday morning.

Shop work consists of instruction in the operation of lathes, planers, drilling machines, bench and floor work, and such other machine work, according to the ability of the apprentice, as pertains to the particular branch of manufacture of the shop where the boy is employed.

The boys receive compensation for shop work, a plan whereby the advantages of a high-school course of instruction may be secured by those who otherwise could not avail themselves of this privilege.

The course of study in detail is appended.

Course II.

COOPERATIVE INDUSTRIAL.

	Hours per week.
First year (all school work):	
English	5
Mathematics, tables, and simple shop problems	5
Mechanics, simple machines	5
Free-hand and mechanical drawing	5
Current events	2
Second year (school and shop work):	
English	4
Shop mathematics	5
Physics	4
Mechanism of machines	4
Free-hand and mechanical drawing	3
Third year (school and shop work):	
English	4
Shop mathematics	5
Physics—chemistry	3
Mechanism of machines	4
Commercial geography and business methods	1
Free-hand and mechanical drawing	3
Fourth year (school and shop work):	
English	4
Civics and American history	2
Shop mathematics	5
Mechanism of machines	5
Electricity and heat	4
Free-hand and mechanical drawing	5

The success in the mechanical work has led the board of education to plan an extension of the work to include commercial and administrative courses that shall also be pursued upon a cooperative plan. The Fitchburg plan is as feasible for railroad shops, and, by extension, for railroad offices, as for the manufacturers' shops where it has been put in force. The only thing lacking is the proper address on the part of the railroad manager toward this important subject. In the case of Fitchburg, the plan originated with the Fitchburg Iron Workers' Association.[a]

ALTOONA HIGH SCHOOL INDUSTRIAL COURSE.

We know of only one case where the railroad has appreciated the machinery which the public schools offer to recruit their services with high-school boys of special training. This is at Altoona, Pa.

The Pennsylvania Railroad Company three years ago undertook a plan of cooperation with the city schools of Altoona, Pa., where the shops are situated. The city has a population of 60,000, of whom 15,000 work in the shops. It is therefore entirely supported by the railroad, and the conditions for shaping a public-school course to railroad requirements are unusual. The company installed some $40,000 worth of tools. The equipment includes a full outfit for carpentry, blacksmith and vise work, a foundry, drafting tables, and a machine shop with shaper, planer, drill-press, lathes, speed lathes, etc., all of the very latest design. The power is supplied directly by individual motors for each machine. The high-school building is on an ample scale and of recent construction, so that the industrial department is not cramped for room.

The city supplies the regular teaching staff, which consists of a chief instructor and four assistants. This chief instructor, Mr. Larson, began as a practical cabinetmaker. He later took a special course at Massachusetts Institute of Technology, and devoted several years to manual training in Berea College and in Cleveland. He was able to supplement his general education by a course at Berea and later at Western Reserve University, and he then took a year's course in Sweden and Germany in his specialty of manual training. His assistants are practical men with varying degrees of theoretical attainment.

It is too early to judge of the work, because at this date no class has completed the course. The course was very popular at first because the Pennsylvania Railroad held out the definite promise of employment in the shops. This employment was to be on some special apprenticeship basis, the terms and rate of pay of which the railroad reserved the right to work out later as conditions might

[a] For an account of cooperative industrial courses, including the Fitchburg plan, see the Report of the Commissioner of Education for 1909, Chap. I, sec. 12.

warrant. But the opportunities offered would be special, and the course of subsequent apprenticeship would be much shorter than four years—possibly only one year. The first class to enter numbered 60. At the end of the third year it now numbers 14. This decline is partly due to the business depression of the past year. Some students have dropped out to go to work, and others, discouraged by the example of so many experienced shopmen out of work (in the present slackness of business), have shifted to the commercial and academic courses. The high-school course builds on a foundation of manual instruction in the lower grades. The plan adheres strictly to the theory of making the work and skill applied incidental to the useful object sought. The articles made are all for some use, especially in the woodworking course. The inflexible rule is that a sketch must be drawn of the articles to be made. This sketch must be taken to the drafting room and reduced to a mechanical drawing to scale, then blueprinted, and the shop work done from the blueprint.

The curriculum is as follows:

FIRST YEAR.

	Credits.
English	2
Algebra	2
German or Greek and Roman history	2
Free-hand and mechanical drawing, joinery, wood turning, metal work	2
Conduct	1

SECOND YEAR.

English	2
Algebra	2
Physical geography and botany	2
Second-year German or mediæval history	2
Mechanical drawing, pattern making, and foundry practice	2½
Conduct	1

THIRD YEAR.

English	2
Plane geometry or English history	2
Chemistry	2
Third-year German (optional)	2
Architectural or mechanical drawing, forging, and vice work	2½
Conduct	1

FOURTH YEAR.

English	2
Physics	2
United States history and civics or solid geometry and trigonometry	2
Architectural or machine drawing, machine-shop practice, and electrical construction	3
Conduct	1

COOPERATION OF THE RAILROAD AND THE HIGH SCHOOL.

The possibilities of the high school in helping to meet a serious need of the railroads, are generally entirely ignored. By a very trifling cooperation, the railroad could make large use of it, first as a recruiting agency, and then, at special railroad centers, as a vocational school in combination with a carefully arranged railroad apprenticeship, by adaptation of the Fitchburg plan. As a recruiting agency, a railroad could turn the attention of the boys to the railroad career by securing the introduction of a very general short course descriptive of railroads and their public functions. The railroad industry is important enough to render such a course attractive from the general cultural standpoint alone. Competitive prize studies about railroads would still further direct the attention of the boys this way, the prize being a railroad scholarship (i. e., regular apprenticeship). In this way the recruiting official of the railroad would have his selection partly made at the outset.

The grave need of the railroad is for carefully trained men to fill the places of chief clerks, foremen, and subordinate officials. If unwise to rely on vocational training entirely outside of the service, there is yet a whole field of railroad facts and railroad lore, and much of railroad technique that could be taught or explained in the class room. Coming from such an atmosphere to an apprenticeship definitely built on to such a course, the boy would make excellent material.

The Fitchburg plan carries the idea further. It is merely an advanced stage of cooperation between school and railroad administration. The first stage needed is a recognized recruiting department on the railroad with a trained railroad man and educator at its head, to confer with the school authorities from time to time and offer a basis of cooperation. This can all be done on a very informal and inexpensive basis. The cost of one surplus switch-engine service that the manager has overlooked and failed to lay off would provide all the resources needed.

X. THE CORRESPONDENCE SCHOOL.

The correspondence school undertakes to formulate the skill, the practical knowledge, and the experience of the skilled railroad worker into word-picture and graphic representation, and in this form to carry them over into the experience and possession of the learner. Its course is necessarily inflexible, and the nice problem is just how much to open to the mind of the student in each stage of advance, and in what order, for only in a partial way can the instructor know how far the student digests the instruction. The method is the catechetical—to insure, so far as possible, that each item of instruction is

driven home. The machinery by which such a method is applied among an enormous body of students scattered over a world-wide area is an innovation in education. It is one of the most unique applications of the division of labor. The courses are mapped out within severely definite lines, and the body of the instruction is reduced to a set of definite answers to a series of numbered questions. In the headquarters office these printed questions and the official answers are assigned in blocks to clerks or checkers. These checkers are young men carefully trained to understand the questions and the proper answers to the questions which are in their individual assignment, and also how to correct and mark the papers received from students. When the answer exceeds their range, the paper is passed up to the division chief, who is a man technically educated and able to handle the case.

Whatever be the limitations of the correspondence school, it has performed a very large service in reducing the best practice in every field of railroad work which it enters to written description and explanation. It is definite, specific, even arbitrary, never speculative. A principle is stated in no more general terms than may be necessary to embrace all its phases in the limited area of the particular course where it occurs. A special skill has been developed in opening up subjects to untrained minds by simple description, definition, and diagram. The avowed purpose is to fit the worker to a standard mold. It is intended for the great body of men rather than for the advanced student. In order not to overwhelm the learner, the course is sent to him in sections, and questions must be answered as the subject is unfolded. Should something in the presentation not be clear, the learner is encouraged to write out what he does not understand and ask for a special explanation.

The correspondence school finds an attractive field among railroad employees, because the working conditions on railroads are largely uniform. Railroad managers, on the other hand, find an educational agency, specialized for some departments of their work, ready to hand and extend special consideration to such agencies. They recommend the courses to their men; in making promotions they sometimes give weight to work done in such courses, and frequently they arrange for collection of tuition fees through the pay roll.

Among the courses arranged are outlines of study for civil, mechanical, and electrical engineers, for draftsmen, trackmen, roundhouse men, train men, station men, machinists, boiler makers, tinsmiths, foundry men, pattern makers, signalmen, wire men, and for locomotive running. Some of these courses, naturally, are not necessarily special to railroad service, such, for instance, as tinsmiths', boilermakers', and machinists' courses. As a sample of a very excellent course, we give below the outline of the work of the

School of Railway Signaling at Utica. Its advisory board is constituted of signal engineers of some 15 different railroads. The following excerpts are taken from the catalogue:

SCHOOL OF RAILWAY SIGNALING (UTICA).

Our methods.—When a student enrolls with us he is given a file number. This number also appears on the acknowledgment of contract which we send him. He is then furnished with two or more instruction papers on the subject which is to be taken up first, so that after completing, say, Part I of a certain subject and mailing his examination to us, he may continue with Part II, while his papers on Part I are being checked. In this way the student will always have one or more instruction papers on hand.

Time required to complete course.—This varies with the aptitude of the student, previous education, amount of time spent each week in studying, etc. The average student should be able to complete the course in eighteen months by studying eight hours per week. Each student is in a class by himself and can therefore progress as fast as he desires.

Bound volumes.—A complete set of volumes covering the entire course is given to each student as soon as he has completed his course. These volumes form a comprehensive signal library.

Illustrations.—The entire course is fully illustrated with numerous cuts, half tones, and diagrams. These aid materially in giving the student a clear understanding of the subject and form a valuable part of the course.

Taking the entire course.—From time to time we receive inquiries from prospective students who desire to take only certain parts of the course. To such we would say that the course is complete as a whole, and it is always best to take the entire course and in this way secure the benefit of a full course of instruction. In this way the student also receives the complete set of bound volumes.

DIVISION OF COURSE.

Drawing.
Arithmetic.
Algebra.
Elements of mechanics.
Heat and light.
Chemistry.
Magnetism and electricity.
Concrete work.
Signal towers.
Materials and tools.
Track work.
Mechanical interlocking.
Wires and cables.
Relays.
Locking.
Track circuits.
Electric transmission lines.
Highway crossing alarms.
Electrical appliances and circuits.
Power operated signals.
Block signaling.
Electric power supply.
Operating rules.
Electro-pneumatic interlocking.
Direct current electric interlocking.
Pneumatic interlocking.
Alternating currents.
Alternating current block signaling.

We append also a few paragraphs quoted from the "Synopsis of subjects:"

Arithmetic.—Definition. Notation and numeration. Addition. Subtraction. Multiplication. Division. Factoring. Cancellation. Fractions. Complex fractions. Decimals. Signs of aggregation. Percentage. Profit and loss. Involution. Evolution. Ratio and proportion.

Drawing.—General methods. Use of instruments. Preparation of paper. Character of lines. Shading. Sections. Railroad curves. Tracings. Blueprints. Dimensioning. Lettering. Sketching. Exercises. Drawing plates. Geometrical problems. Projections. Working drawings. Mensuration. Table of curves. Drawing plates.

Algebra.—Definition and notation. Signs and their uses. Factors. Coefficients. Multiples. Powers. Roots. Algebraical expressions. Parentheses. Positive and negative numbers. Positive and negative quantities. Subtraction of scalar numbers. Addition of scalar numbers. Addition. Subtraction. Multiplication. Division. Equations. Statement and solution of problems.

Elements of mechanics.—Matter. Motion and force. Resultants. Gravitation. Action of the force of gravity. Work and energy. Theory of the pendulum. Theory of the lever. Theory of the wheel and axle. Theory of the screw. Compound machines. Mechanics of fluids. Water power. Theory of capillary action. The barometer. Pneumatic machines. Transmission of pressure, etc.

Heat and light.—Theory of heat. Temperature. Transmission of heat. Effects of heat. Specific heat. Heat and work. Radiant energy. Theory of light shadows. Photometry. Theory of reflection. Theory of plane mirrors. Theory of spherical mirrors. Theory of refraction. Total reflection. Foci of convex lenses. Foci of concave lenses. Images formed by lenses. Theory of the composition of light. Optical instruments, etc.

Chemistry.—Definition. Atoms and molecules. Symbols. Formulas. Radicals. Chemical elements. Metals and nonmetals. Chemical changes. Equations. Laws of combination. Nomenclature. Laws of reaction. Valence directions for writing reactions. Elements and compounds.

The general foundation on which the course is laid is indicated by this synopsis. As a fair illustration of the way some of the subjects are developed we select further the abstract of the papers on track work and on mechanical interlocking:

Track work.—General remarks. The right of way. Chaining. Chaining stations. Starting point. Treatment of curves and tangents. Point of curve. Point of tangent. The standard rail. The lift rail. The guard rail. Types of frogs. Types of switches. Types of switch stands. Types of derails. Tie plates. Riser plates. Wooden cross-ties. Concrete cross-ties. Metallic cross-ties. Railroad spikes. Splice bars. Switch rods. Rail braces. Tools. Classes of ballast. Cuts and fills. Drainage. Grades. Gauge and alignment. Expansion and contraction of rails. Heaving and settling. Leveling. Tamping ties. Sidings. Crossovers. Crossings. Station platforms. Bridges. Clearances. Use of hand and push cars, etc.

Mechanical interlocking.—Functions of mechanical interlocking. General description of interlocking machines. Construction, operation, installation, and maintenance of the Saxby & Farmer interlocking machine. Preliminary latch locking. Construction, operation, installation, and maintenance of the Standard interlocking machine. The Johnson interlocking machine. The National interlocking machine. Dwarf interlocking machines. Ground lever stands. Method of adding one lever to interlocking machines. Construction, installation, and maintenance of rocker-shafts, deflecting bars, and box crank leadouts. Ground connections: Pipe line, pipe carriers, cranks, jaws, pipe lugs, pipe compensators, deflecting bars, rocker shafts, wire and wire carriers, wheels, wire compensators, wire connections, stuffing boxes. Operation, installation, and maintenance of ground connections. Drawbridge devices. Construction, operation, installation, and maintenance of switch connection. Single switches. Derails. Movable point frogs. Single and double slips. Construction, operation, installation, and maintenance of signals. Ground poles. Bridge signals.

Cantilever poles. Dwarf signals. Pot signals. Mechanical slots. Selectors. Signal lamps. Signal foundations. Crossing bars. Painting and boxing. Time locks. Specifications, etc.

INTERNATIONAL CORRESPONDENCE SCHOOL.

A locomotive running course of the International Correspondence School is a good illustration of a course designed on strictly practical lines. The division of the subject is as follows:

Locomotive Running.

INSTRUCTION PAPERS INCLUDED IN COURSE.

Specifications, etc.
Air-brake pumps.
Triple valves and brake valves.
Air-brake troubles.
Operating and testing trains.
Foundation brake gear.
Air-signaling system.
High-speed brake.
Locomotive boilers.
Boiler attachments.
Heat and steam.
The locomotive.
Valves and valve gears.
Locomotive management.
Breakdowns.
Train rules.
Vauclain compound locomotives.
Cross-compound locomotives.
Tandem and balanced compound locomotives.
New York air-brake pumps.
New York triple valves and brake valves.
New York air-brake troubles.
Train operation.
New York foundation brake gear.
New York air-signal and high-speed brake.
*Car lighting.
*Car heating.
*Electric headlight.
*Arithmetic.

The student is required to study either the instruction papers in above list relating to the Westinghouse air brake or those relating to the New York air brake; but he may study the papers treating of the Westinghouse air brake and omit the study of those treating of the New York air brake; or he may do the reverse, study the New York air-brake papers and omit the study of those treating of the Westinghouse air brake; if he desires, he may study both sets of papers.

CERTIFICATE REQUIRED.

Our locomotive running scholarships are sold only to engineers and firemen; and the contract for scholarship must be accompanied by a certificate that the person making application for enrollment is employed in that capacity, signed by one of the following-named officers of the railroad company by which he is employed: Superintendent of motive power, assistant superintendent of motive power, master mechanic, assistant master mechanic, roundhouse foreman, or assistant roundhouse foreman.

The very practical character of the instruction is again illustrated by the synopsis of instruction in operating and testing trains, in handling breakdowns, and in train rules:

Subjects marked * are optional.

OPERATING AND TESTING TRAINS.

The make-up of a train.—Effects of slack, of unevenly distributed loads, of unequal piston travel, of length of train pipe. MAKING UP FREIGHT TRAINS: All-air trains; part-air trains; testing brakes, engine equipment, the air pump, pump governor, brake valves, driver and tender brakes, triple valves. TERMINAL TEST OF TRAIN: When test should be made, making the test, brake fails to apply, brake releases, brake fails to release, train-pipe leaks, cutting out a brake, cutting out a car. RUNNING TEST—TEMPERATURE TEST: Locating defects. HANDLING TRAINS: Service stops, definition of reduction and application; first reduction; succeeding reductions; number of reductions; passenger-train stops; two-application stops; overcharging train pipe; number of applications; holding brakes on; stopping by means of tail-hose; part-air freight trains; use of hand brakes; water-tank and coal-chute stops; all-air freight trains. EMERGENCY STOPS: Brake stops, reversing the engine, accidental emergency stops. RUNNING: Position of brake valve; setting out a car; picking up cars; hose bursting; bleeding brakes off; breaking-in-two of train; handling trains on long down grades; quick action during service reduction; locating defective triple; brakes stuck on; use of sand; wheels sliding; use of conductor's valve; double heading.

Breakdowns common to all types of engines.—Broken or burned-off grate bars; burst flues; slipped eccentrics, locating a slipped eccentric, setting slipped eccentric; broken forward-motion eccentric cam, strap, or rod; broken back-motion eccentric cam, strap, or rod; broken link hanger, saddle pin, lifting arm, or tumbling shaft; broken rocker-arm, link-block pin, or transmission bar; broken cylinder head; broken reverse lever or reach rod; broken valve-stem stuffingbox gland; broken piston-rod stuffingbox stud and lug of gland; broken valve yoke; broken false valve seat; broken steam chest; broken piston rod or piston; throttle disconnected and closed; throttle disconnected and open; hole knocked in boiler; pop-valve or whistle blown out or broken off close to dome; blow-off cock blown out or broken; extra precautions for cold weather; broken frame; disconnecting rods, valve rods, strap-end main rods, solid-end main rods; blocking the cross-head; taking down side rod of eight-wheel engine, mogul or ten-wheel engine, or consolidation engines; broken valve seat; broken valve; broken steam chest and cylinder; broken main crankpin; broken back-end main-rod strap; broken front-end main-rod strap; broken guide; broken crosshead-bent piston rod; broken piston rod; broken wedge bolt; broken driving box or brass; broken four-wheel engine-truck axle; broken engine-truck equalizer; broken tender-truck wheel; broken tender-truck axle; broken tender-coupler casting. BREAKDOWNS PECULIAR TO CERTAIN TYPES OF ENGINES—EIGHT-WHEELED ENGINES: Broken side rod or back pin; broken tire on front driver; broken tire on back driver; broken front axle; broken back axle; broken front driving spring or hanger; broken back driving spring or hanger; broken equalizer. TEN-WHEELED ENGINES: Broken front section of side rod; broken back section of side rod; broken front tire; broken main tire; broken back tire; broken axle on front driver; broken main axle; broken axle on back driver; broken front driving spring; broken main driving spring, underhung rigging, overhung rigging; broken back driving spring, underhung rigging, overhung rigging; broken spring or spring hanger on truck. ATLANTIC TYPE ENGINE: Broken side rod on front pin; broken tire on front driver; broken tire on main driver; broken tire on trailer wheel; broken front axle; broken main axle; broken axle of trailing wheel; broken main driving spring, overhung rigging, underhung rigging; broken front spring; broken trailer spring. NORTHWESTERN TYPE ENGINE: Broken side rod or front pin; broken tire on front driver; broken tire on main driver; broken tire on trailer; broken front driving axle; broken main axle; broken trailer axle; broken front driving spring; broken main driving spring; broken trailer spring; broken trailer-spring front hanger; broken trailer-spring back hanger; broken cross-equalizer; broken trailer equalizer; broken intermediate equalizer. MOGUL ENGINE: Broken back section of side rod;

broken front section of side rod; broken tire on front driver; broken tire on middle driver; broken tire on back driver; broken axle on front driver; broken axle on main driver; broken axle on back driver; broken front spring or hanger; broken main spring; broken intermediate equalizer; broken long equalizer; broken front pin of truck equalizer. CONSOLIDATION ENGINE: Broken front section of side rod; broken middle section of side rod; broken back section of side rod; broken tire on front driving wheel; broken tire on second driver; broken tire on third, or main, driver; broken tire on back driver; broken front driving axle; broken second driving axle; broken third, or main, axle; broken back driving axle; broken front driving spring; broken second driving spring; broken cross-spring on Brooks consolidation; broken long-truck equalizer; broken front pin of truck equalizer. SWITCH ENGINES: Broken springs; broken equalizer; broken forward tire or axle; broken middle tire or axle; broken back tire or axle.

TRAIN RULES.

Introduction.—Purpose of train rules; by whom code is prepared; thoroughness of code; prime requisites of railroading; duties of employees. TRAIN RULES: Definitions; time table; standard time; government of trains by time table; meeting and passing points; visible signals; audible signals; air-whistle or bell-cord signals; train signals, engine lights, markers, trains running in sections, double-heading, signal given by train carrying following section signals, engine pushing cars, signaling from cars to engine, protecting workmen under engine, signals imperfectly displayed, flag-station stops, ringing engine bell. CLASSIFICATION OF TRAINS: How classified; train losing its rights. MOVEMENT OF TRAINS: Train leaving initial station; starting a train; inferior and superior trains; approaching meeting and passing points; trains moving in same direction; train to run on time; overtaking a superior train; displaying signals for following section; running of work extras; approaching junctions, crossings, etc.; trains stopping or being delayed; train parting while running; precautions when pushing cars; orders to be in writing; communications from flagmen; care of switches; responsibility for safety of train; moving on the proper track; crossing from one track to another; use of track at a passenger platform; standard code train rules for single track. TRAIN ORDERS: General considerations; carrying out orders; use of train orders; nature of train orders; preparation of train orders; issuing of train orders; filling out train orders; keeping record of orders issued; wording of orders; transmitting orders; preparing form 19; noncompletion of order; duplicates of order; delivery of order at nontelegraph station; meaning of word train in an order; giving X response; life of train order; fulfilling, superseding, or annulling an order; rule 221; form A; form B; keeping record of train movements; forms of orders; clearance card; standard code of train rules for double track.

TRAIN OPERATION.

The trainmen's and carmen's courses are largely devoted to the handling of air brakes and of apparatus for the heating and lighting of cars, and to the understanding of train rules. The courses lead directly to practical fitness for the requirements of standard practice. This is especially illustrated in the locomotive running and trainmen's courses, by the fact that the only study of general principles is comprehended under the subject of arithmetic, and this goes only through long division and fractions to decimals.

The students who take these courses are, naturally, the boys and young men who are either regular apprentices, or are in the early stages of a course of promotion which is recognized as practically an

apprenticeship. Thus they are roundhousemen and firemen seeking to be engineers; or they are boiler makers' and machinists' apprentices; or forward brakemen of passenger or freight trains. In addition to this, the courses frequently attract those not at the time in railroad service who hope through study to become eligible. That is, the motive, for the most part, is not so much to perfect oneself in the work where employed as to fit for the next stage of possibility. The stimulus throughout is the hope of enhanced earning power, which, in the case of the great body of railroad employees, comes only with advancement to the next grade of service. The number of men who at some time take these courses is very large. The writer was informed that the representative of a correspondence school at Altoona, on the Pennsylvania Railroad, has at this writing some 3,000 students on his register.

Between the promise of the prospectus and the results achieved is a wide gap. The learners are raw, untrained boys and young men living in an atmosphere uncongenial to study, with little power of mental concentration, and of fitful zeal. The percentage of lapses is necessarily high and those who fall out become discouraged. But so long as the correspondence course does not essay to compete with real school work, its net results, notwithstanding all the failures, are on the credit side of the ledger. Those who have persevered have found in it their opportunity, and those who have failed have nevertheless learned a few things—especially have they come to realize that there are definite standards of excellence and intelligence in their work. This so far tends to set up the workmanlike and professional spirit.

The popularity of the correspondence school points to the need which exists in this field. It should be recognized as a stage toward the ideal condition of apprenticeship and resident instruction in combination. From the correspondence school as it now is, railroad managers frequently expect too much. But the tuition fees are sufficiently high to justify these schools, it would seem, in planting resident instructors at the larger railroad centers, and giving their students personal supervision. A little care in accepting students, and in advising with them on entrance as to the work they could best pursue, would save such enterprises from the appearance of excessive commercialism, which is a cause of much criticism to-day.

The method of the correspondence school has so far justified itself that sometimes railroads themselves have formed a sort of cooperative correspondence school among the officials of several roads in a given locality. Some of the division officials (at New York City) of the New York, New Haven and Hartford, the New York Central, and the Lackawanna railroads for some time conducted such a school. The defect of excessive commercialism was absent. The officers who supervised the work were properly compensated; but

there was great caution exercised not to encourage the hopelessly unfit to take the course. It served as a recruiting agency for the roads interested at a time when good labor was exceedingly hard to get.

EDUCATIONAL BUREAU OF INFORMATION OF THE UNION PACIFIC RAILROAD.

The most recent and comprehensive departure made by any railroad in using the method of the correspondence schools is that evolved by W. L. Park, general superintendent of the Union Pacific Railroad, and inaugurated by that railroad under Mr. Park's general direction September 1, 1909. The railroad has established what it calls an "Educational Bureau of Information." In describing this, Mr. Park writes the following:

Our objects in establishing this school are to reach the young man who has not been permitted to remain in school after 16 years of age (of which there are 90 per cent of the entire population of the United States), and to promote loyalty through appreciation of the company's interest in the welfare of the employee, bringing about courtesy to patrons and raising the entire personnel to a higher plane.

The advisory board is composed of general officers, a majority of whom have college educations—all thoroughly practical. The chief of the bureau is a graduate of Purdue University, a mechanical engineer, and for several years employed as a locomotive fireman, assistant air-brake inspector, and also for several years with one of the large correspondence schools, a good part of the time in charge of the dynamometer car, employed in inspecting transportation on different railroads. The assistant chief of the bureau is an expert accountant, agent, and traffic man. The tutors are from the ranks, selected by reason of special qualifications from both educational and practical view points. The work is educational on the lines of now existing correspondence schools, by field work and by actual school work, the latter given mostly to agents and mechanical apprentices, the entire scheme on the partial time educational methods now coming into vogue, but extended to all employees, regardless of age or educational qualifications. We can teach every student something. It is not the object of the bureau to make officials, but to make more efficient employees, from whom will naturally come those who are qualified to become officials. The bureau has no prestige as to promotions, which are made as heretofore on the recommendation of the immediate superior, but the stepping stones afforded by the school places in the hands of those ambitious to advance the means to do so.

The course commences with:

1. A paper on how to study.
2. The history of the Union Pacific.
3. Geography of the Union Pacific.
4. General.
5. Geographical parts, embracing in their entirety each of the divisions of the road.

From this the papers branch into Mechanical Engineering, Signal Work, Transportation, Traffic, Maintenance of Way, Civil Engineering, Agents' Course, Air-Brake Course, Locomotive Firing, Locomotive Running, etc.

The scheme is an innovation. It eliminates from mechanical engineering, marine work, hydraulic engineering, etc., and specializes on railroad mechanical engineering. This is true of all courses, teaching only that which is applicable to railroads, and particularly to the Union Pacific, using our standards, rules, and specifications.

The men take to the scheme—it is something they have long wanted. In the three months since the bureau was established over 500 students have been enrolled, all earnestly pressing their special work to the extent that success is assured, the possibilities are unlimited. The bureau work is gratis to employees; it does not in any way compete with established schools; it fills a place not now occupied, extends to all employees that which has heretofore been confined to only a few mechanical apprentices, and makes more efficient employees, arousing an interest in general knowledge which will call for further investigation extending beyond that which our school will afford.

Thus we see that out of the railroad organization has been designated a staff of experts in their various lines of specialty, who have severally undertaken the development of courses in their specialties. For this service they receive special compensation from the railroad in addition to their regular compensation in their regular duties. The enlistment of such highly specialized and practical men under a competent director who can edit, digest, and coordinate the contribution of each from his department assures a literature of practice probably advanced above anything so far developed. When a group of men of such training are called upon to devote part of their time to reducing to statement the principles of practice in their every day routine, and then to the instruction of eager young men widely scattered through the service, such instruction to be parallel with and explanatory of their daily work, the results must be large.

The method of inaugurating this school and a résumé of its working schedule are set out in the circulars of the general superintendent. Nos. 23 and 24, as follows:

UNION PACIFIC RAILROAD COMPANY,
OFFICE OF GENERAL SUPERINTENDENT,
Omaha, August 25, 1909.

CIRCULAR No. 23.

Announcement of plans and privileges of the educational Bureau of Information of the Union Pacific Railroad Company, referred to in General Superintendent's Circular No. 22, August 20, 1909.

The fundamental reasons for establishing the educational Bureau of Information are:

First. To assist employees to assume greater responsibilities.

Second. To increase the knowledge and efficiency of employees.

Third. To prepare prospective employees for the service.

The privilege of using this bureau is open to all departments and employees free of any charge, the company maintaining the bureau for the benefit of the entire service.

The work of the bureau will be controlled by a board of supervisors consisting of the following officers of the company: Vice-president and general manager, freight traffic manager, general superintendent, chief engineer, superintendent motive power and machinery.

An advisory board, consisting of employees selected from the various departments, will act with the chief of the bureau in handling all questions relating to their respective departments.

All communications will be addressed to "Chief, Bureau of Information, Pacific Express Building, Omaha, Nebraska."

ASSISTING EMPLOYEES TO ASSUME GREATER RESPONSIBILITIES.

The bureau will offer any employee desiring to qualify himself to assume greater responsibilities a course of reading and study along the line which he may indicate. This course will be conducted somewhat on the method of now existing correspondence schools, and will be prepared with special reference to the needs of the particular case. This course need not necessarily be confined to the particular work of the department with which the employee is connected, but may embrace any subject, the knowledge of which may be of value to the employee in the position now occupied or which would help to qualify the employee to change positions to a line of work which would be more nearly suited to the ambition or desire.

An employee taking up a special line of work of this kind must show his interest in it by doing a reasonable amount of reading or studying. Otherwise the company will not be justified in continuing the expense of maintaining the employee on its student rolls.

Those selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors.

INCREASING THE KNOWLEDGE AND EFFICIENCY OF EMPLOYEES NOW IN THE SERVICE.

This bureau offers to all employees the opportunity to increase their knowledge, thereby increasing their efficiency, by means of the information department feature. Employees desiring information on any problem or proposition connected with their work, or on railroad matters in general, can, without any formality, address this bureau, stating the information desired. Name and address, position or occupation, division, district, office, or shop where employed should also be stated.

This information will be furnished promptly and in as simple and practical a manner as possible.

All inquiries will be addressed to the chief of the bureau of information, but any inquiry requiring special departmental information will be referred to the member of the advisory board best qualified to give the information desired, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas, or precedents of the department to which they relate. Questions referred to members of the advisory board will not carry the names of the employees desiring the information, although a record will be kept available to the heads of departments wishing to know who of their employees are seeking to increase their knowledge of railroad matters.

It is the intention to further this work by means of lectures on live railway subjects, to be given from time to time at various district headquarters. Pamphlets and reports will be distributed periodically, containing information on subjects of interest. Classes will be organized at various points to teach important subjects, and a representative of this bureau will be continually on the road to handle matters which can not be properly explained or demonstrated by correspondence.

PREPARING PROSPECTIVE EMPLOYEES FOR THE SERVICE.

This bureau will be glad to register the names of dependents or relatives of employees who wish to enter the service of the company, and will also keep in touch with various universities, colleges, high schools, and technical schools for the purpose of having at all times material on hand to supply help desired by any of the departments. Persons registering with this bureau may indicate the particular line of work which they desire to follow. They will be given every opportunity for learning the elementary methods and requirements of the department they wish to enter, and while

it is not promised that positions will be given to all applicants, it is, however, expected that the various departments will avail themselves of this opportunity for filling vacancies in their ranks from individuals registered with this bureau who have taken advantage of the opportunity to qualify themselves for the positions desired.

W. L. PARK,
General Superintendent.

Approved:
A. L. MOHLER,
Vice-President and General Manager.

UNION PACIFIC RAILROAD COMPANY,
OFFICE OF GENERAL SUPERINTENDENT,
Omaha, October 20, 1909.

CIRCULAR No. 24.

In connection with General Superintendent's Circulars Nos. 22 and 23, regarding establishment of an educational bureau of information, the following extracts from the proceedings of the fourth annual meeting of operating officials of the Union Pacific Railroad Company, held September 24, 1909, are reproduced in this form for the purpose of giving a better understanding of the objects of the bureau.

By Mr. BUELL, chief of the bureau:

* * * * * * *

Each of the objects of the bureau will be discussed separately.

First object.—Assisting employees to assume greater responsibilities.

All practical railroad men realize that much of their work is governed by what may be termed unwritten laws. Few books are published which give practical information of value, and many employees are so situated that it is impossible under present conditions to acquire a working knowledge that will fit them to assume greater responsibilities. You gentlemen have had the perseverance to work out your own betterment; have used your eyes, ears, and brain to learn all you could of the reasons for doing things that were going on around you daily, and by your fitness have overcome your difficulties and risen to your present official positions, but who can tell how much hardship and how many mistakes might have been saved had you had the opportunity to learn much of this unwritten law, gleaned from the experience of, and put in practical form by, those who had "gone through the mill" before you.

It is the purpose of this bureau in its first object to furnish courses of reading and study especially prepared under the direction of the advisory board to cover as much of this so-called unwritten law as possible, and to combine with it such existing instructions and written matter as will assist an employee to assume greater responsibilities in the line of his work.

The course will be conducted somewhat on the method of now existing correspondence schools.

The privilege of taking a course of this kind is offered to all employees by the part of General Superintendent's Circular No. 23 reading as follows:

"The bureau will offer any employee desiring to qualify himself to assume greater responsibilities a course of reading and study along the line which he may indicate. * * *

"This course need not necessarily be confined to the particular work of the department with which the employee is connected, but may embrace any subject, the knowledge of which may be of value to the employee in the position now occupied or which will help to qualify the employee to change positions to a line of work which would be more nearly suited to the ambition or desire."

This statement was made broad enough so that no employee need hesitate to state what he wanted the bureau to do for him or what line of work he was ambitious to master. Certain reasonable qualifications, however, are implied, and these are concisely set forth as follows:

Firemen, until they have passed promotion examinations in rules, air brake, and machinery, will be assisted only on matters pertaining to the knowledge necessary to pass these promotion examinations.

Brakemen, switchmen, etc., until they have passed all promotion examinations for conductors, yard foremen, etc., will be assisted only by answers to such questions as they may ask the information bureau, although we do not limit the number of questions they may ask. An exception to this will be made in the case of brakemen having had three years' experience, or more, one year at least of which has been served on the Union Pacific Railroad, in which case an advanced course may be taken up with the permission of the general superintendent.

Stenographers, clerks, etc., will be allowed to take up studies pertaining to the department in which they work as long as they are not of too advanced a character, and in special cases where they are anxious to get into a different line of work they may be allowed to take up a study of work in other departments, by the approval of the general superintendent.

It is not the intention to teach elementary or rudimentary subjects, such as arithmetic, writing, spelling, grammar, etc., which can be learned in ordinary night schools or business colleges, except in certain particular cases, such as shop classes for apprentices, or where an employee is located at such a point that there is no other way for him to get this training and the training of this man in the particular subject would be a benefit to the company.

In planning the different courses now in preparation it was thought best to require each student to familiarize himself with the history of the Union Pacific, its geography and resources, and to also give an outline of the federal and state laws which affected the road. In all cases this will probably be the first work of the different courses.

Courses are now being prepared on:

The maintenance of automatic block signals.
Mechanical engineering as applied to railroad work.
Track work in both English and Japanese.
Station work.
Freight traffic.
Accounting.
Railroad operation.
Electric lighting and power.
Questions and answers for firemen studying for promotion examinations in machinery.

Additional courses planned are:

Gasoline motor car work.
Analysis of statistics.
Maintenance of interlocking plants and their construction.
Car building.
Shop practice.
Civil engineering as applied to railroad work.
Refrigeration.

The courses now being prepared all start with the elementary work and lead up step by step so as to give a general practical knowledge of the subject. Students assigned to these courses will be started on the first work, and while it will be in the nature of a review for some of them it is hoped they will all profit to some extent by a study of this elementary work, thus insuring a thorough knowledge of the subject as they progress, and that they will have patience with the bureau until the more advanced work can be gotten out.

The first work will be sent out about November 1.

Where special courses are asked for, the applications will be considered by the advisory board and the course furnished, if practical, at as early a date as possible. The lessons will be sent out to students in two forms: First. Lessons which have been specially prepared by the bureau will be mimeographed on standard letter-size paper, with cloth binding, and student may keep these. Second. Instructional matter to be studied from books already printed will be outlined, showing just what parts of the printed work must be mastered, and this outline sent to the student with the book. These books will simply be loaned to the student, and he will be held responsible for their safe return, and in case of failure to return them they will be charged against him at cost price.

The books may be kept a reasonable time, student being notified as to when he should return them. An extension of time will be allowed for good cause.

A set of questions will be sent with each lesson. Written answers must be submitted and show a satisfactory understanding of the work before additional lessons will be furnished. Students must show interest in their work by doing a reasonable amount of studying. They will not be crowded, but lapses of several months without reasonable excuse will be considered sufficient grounds for dropping them from the student rolls.

Application from employees are numbered consecutively as received and a blank form sent out to be filled in with information as to the education and practical experience of the applicant, together with a statement as to whether he has made a special study of any subject, is a subscriber to any technical magazine, or a student of a correspondence school. He is also asked to state what he desires the bureau to do for him; the information he wants; what line of work he wants to advance in, and what (in reason) he is ambitious to become.

This application, when complete, is considered by the advisory board, and if the information requested is of the proper sort the course is assigned.

If, however, the request is such that any of the qualifications above noted are in effect, then further correspondence is had with the applicant until something can be assigned that is satisfactory to both the applicant and the advisory board.

Men selected for advancement to minor official positions will be afforded an opportunity, before formal appointment is made, of acquiring a knowledge of the practical workings of such departments as they have not been intimately connected with, through a temporary connection therewith under the direction of the heads of such departments, and at a salary fixed by the board of supervisors.

Complete records will be kept of the student work done by employees.

Second object.—Increasing the knowledge and efficiency of employees.

Rarely a day passes in the course of a busy man's career but that some question comes to his mind on which he would like information. The majority of such questions, however, go unanswered unless some pressing necessity makes it imperative that time be taken to obtain the answer. Workmen hesitate to ask too many questions of their foremen, foremen let some point go rather than to show their lack of knowledge, and some officials even clothe their lack of knowledge on occasional points in the mantle of reserve rather than to risk their official dignity by asking a question of a subordinate who assumes their knowledge to be universal. Many questions which are asked are answered in such a way that the questioner does not understand the point clearly, and rather than to appear dull or slow the matter will often be dropped.

It is the purpose of this bureau in its second object to provide a means whereby any employee desiring information on any particular question or problem met with from day to day can send this question to the bureau for an answer. There is no formality connected with this matter; all that is necessary is to write the question and mail it to the bureau, giving name and address, where employed, also position or occupation.

The information will be furnished through the bureau in a simple and practical manner and as promptly as possible. In about a month this bureau will have its own telegraph office and officials can get information direct by wire, using cipher code if desirable.

Questions, when received, are copied and referred to the member of the advisory board best qualified to answer them, it being the intention to have all inquiries answered in such a manner that they will in nowise conflict with the instructions, ideas, or precedents of the department to which they relate. The answers are held and passed on by the advisory board at the first meeting and are then sent to the questioner. It is not the intention to have questions requiring the official ruling of some particular person sent to the bureau, but if such questions are received it is the intention to handle them through the bureau, having the proper member of the advisory board send them to the proper official for a ruling, after which they are returned to the bureau. In cases of this kind the questioner, when his answer is returned, will be requested to refer such matters through the regular channels in the future.

All questions are handled impersonally; the name of the questioner is not shown on the question when it is passed to the advisory board member for handling, only the questioner's occupation being given, nor is the name of the advisory board member furnishing the answer shown. No limit is set on the number of questions that may be asked, and an employee may ask for information every day, if he so desires.

A record is kept of all answers, catalogued for easy reference, and a card catalogue shows which of the employees are taking advantage of this branch of the bureau.

Third object.—Preparing prospective employees for the service.

The promotion of desirable men and the elimination of undesirables creates a constant demand for new material throughout the organization. The demand is perhaps greatest for:

Station helpers,	Signal men,
Operators,	Freight house men,
Agents,	Clerks,
Brakemen,	Common laborers.

It is the purpose of this bureau in its third object to assist in supplying men of good reputation and character for vacancies of this order, and where possible to train these men as far as practical in the duties of their prospective work before their employment.

To this end, applications for employment will be received by this bureau, preference in all cases being given to dependents or relatives of employees.

The personal history of all applicants will be obtained, references investigated, and each applicant required to take a physical examination to assure us that he can pass our requirements, if his record is satisfactory and we wish to employ him.

The names of all available applicants will be kept on file at the bureau, and any official wishing help can apply to the bureau for it.

If satisfactory material is on hand, it will be furnished immediately.

This bureau, however, will not solicit positions for applicants. Requests will have to come from the general organization to this bureau if assistance is desired, and the interest of the bureau in the men furnished ceases when they are employed, unless later they take advantage of the privilege of the information or educational features.

Applications of experienced railroad men, when received, will also be looked up by this bureau and their names placed on file, although it is hoped that all positions suitable for men of this class can be filled from our own ranks.

The names of student employees making marked progress in their studies will be placed before the general superintendent for his information, and it is hoped that in this way men available for promotion will have a better chance to connect with vacancies which they may be qualified to fill, and thus the necessity for going outside our ranks to fill such positions be still further reduced.

Where practical to do so, the elementary lessons of suitable courses may be sent to applicants whom we think we will have use for in the future, so that they can be preparing themselves to give better service when employed.

In addition to the foregoing, there will be established under this third object schools at the bureau's offices for the preparation of student operators, brakemen, and signal-service men by personal instruction. Students of telegraph schools preparing for positions as student operators will on graduation from their course in telegraphy be brought to Omaha and put through a course of training of from two to four weeks in a model local station fitted for this work.

This station will be equipped with the regular local station furniture and forms, wires will be cut into an operator's table; tariffs, tickets, baggage checks, time cards, etc., will be used to familiarize these students with the actual work they will have to do when they go in service, and an instructor will direct their work and see that they have the knowledge necessary to give satisfactory service before they are sent out.

The training of applicants for positions as brakemen is a more difficult proposition, but it is hoped that men can be taught the operating and block-signal rules, the signals, how to pack hot boxes, and care for their markers and lanterns.

In addition to this, and probably most important, there will be instilled into them the knowledge that honesty, sobriety, careful attention to duty, and the observance of all rules and regulations will assure them of a steady job and the right to hope for future promotion.

The training of applicants for positions in the signal department will be accomplished by actual work on batteries and signal appliances, installed as a part of the school's equipment, and while this school in these branches will be experimental, there is reason to hope that the experiment will be a success, as proved by better material furnished due to its establishment.

I want to tell you something of the results accomplished to date (September 24, 1909), and a little about our forecast for the future.

This bureau was announced to commence operation September 1. Since that date there have been 157 applications for courses of instruction received from employees in the service. Of these 157 applications, just one has been impracticable. What I mean by impracticable is where the man has wanted to be president or something of that kind. With this exception, the other 156 of these applications have all shown a definite want on part of the employee asking for instruction. He has told what his position was and has said he wanted certain things that he could not get in any other way or had not gotten in other ways. We rather expected the percentage of applications that were not sensible to be high; that a good many of the younger men in the service would ask for things that were beyond them, but with the exception noted the correspondents have all shown a definite desire for some certain thing.

The class of these applicants range from assistant superintendents, train masters, traveling engineers, and division foremen down through the entire organization to track laborers and engine wipers, and the courses asked for have covered almost as wide a range as do the positions of the men who ask for the courses. There have been quite a few cases where men have asked for training outside of their departments. These, of course, are all being followed up, and courses will be suggested, as outlined in the paper, that will prove satisfactory to the student and which the advisory board will feel justified in allowing students to take up.

Under the second heading of questions that are asked of the bureau, there have only been twelve questions sent in so far, and we feel as soon as the men realize a little more thoroughly the privilege they have in asking these questions that a great many more will come in.

The questions asked have ranged from technical matters down to very simple things, but I feel satisfied that the department will grow more and more as the men realize they have an opportunity of having their daily questions answered as they come to mind.

Under the third object, we have received 64 applications to date from outside parties; that is, parties not in the employ of the Union Pacific. I am very sorry to say, however, that the ratio of applications from outsiders to applications from relatives of employees is low. There have been 60 applications from outsiders who have seen newspaper write-ups of the "Harriman" scheme, as it has been termed in the papers, who have asked for information and expressed a desire to take up work in this school. There have been only four applications to date from relatives or dependent members of employees' families. It is hoped that as soon as the employees realize the advantage offered there will be more of them who will have their relatives apply for positions. In other words, we are a whole lot surer of an employee's son, or some member of his family, than we are of some boomer we know nothing about who has no interest in staying with the company.

Looking into the future of this department, the problem is such that it may turn into a very big affair. We have a sufficient number of employees on the line who, when they realize the advantages that are offered, will take some study or use the bureau in some way, so that we expect it to develop into a pretty big undertaking. The officials, however, have realized that it would develop into a big undertaking and they have not hesitated to go into it, realizing the fact that, while we can not attach a dollar and cents value to information imparted to our employees, still we all realize there is an actual dollar and cents value to the betterment of the knowledge of men in the service.

We can make a forecast of some future work. It is possible that we may be able to cooperate with the present apprenticeship classes and put them on a broader basis. It is possible that night classes will be established in Omaha at the bureau's schoolrooms for the assistance of the men here at this point. We have at the bureau office the nucleus of a library of technical, railroad, and scientific books. We expect to have growing from the nucleus that is started as good a library as can be gotten on those subjects, and from the courses prepared from time to time to secure something that will be really valuable. It is possible that the library will be thrown open even as for use of employees at Omaha, and it is also entirely possible that some scheme for circulating these books over the system will be devised. That, I think, however, will be limited to the officials of the line, because such employees as want this information should get it through the various courses.

Plans have been instituted to issue pamphlets from time to time and to deliver courses of lectures at various points along the line.

In addition to the local and correspondence work that will be done, Mr. Siever, assistant chief of this bureau, will devote considerable of his time to going over the road, handling matters which require personal attention. In this way we will be in touch with work being done in all three departments, and while his time will be devoted principally to the work of the local school here, in educating the station helper students in telegraphy and assisting with the other school work, we plan to use a certain amount of his time, which will be devoted to matters on the road that can be handled better personally than by correspondence. Mr. Siever's success in handling the telegraph students, in spite of the many handicaps he had before him, makes us feel satisfied that we are going to get something out of the school here in Omaha, where we can get at the boys directly and teach them the things that it is necessary for them to know.

We are allowed to use the railrond mail for all correspondence relating to Union Pacific matters, so there will be not even the cost of postage to the men.

* * * * * * *

Mr. PARK: Mr. Buell touched on one subject I desire to speak about, which is probably not a part of the school—at least will not be so considered. It is the fitting of officials for increased responsibilities. This is somewhat experimental, but our ideas so far have been started in connection with one of the train masters. We have appointed a substitute train master and taken one of the train masters who has now been in the service a year, and started him out on this new work by which he can gain experience which will be of value to him further along. He is now in charge of an extra gang on the Utah division. As to his qualifications. He has been a conductor and had some little track experience. He was given charge of this extra gang and will probably be so employed for two or three months, at which time it is expected he will

take up, in connection with the school, a study of maintenance of way work. After he has gotten some idea of maintenance of way work, it is the intention to place him in one of the shops, assisting the gangs, to take down and set up locomotives, and do other work which will give him a more extended knowledge of the machines used in transportation.

I think there is no doubt, after he has been in the shop two or three months, he will have a better knowledge of the locomotive than he had before.

It will then be our intention to put him in one of the accounting offices—perhaps auditor of passenger accounts, so that he will there observe reports of conductors and agents as they are coming in. Attention will be called to errors they make and corrections that are necessary to be made from that office; and in that way he certainly must acquire an inside knowledge of that part of his supervision.

We then desire to pass him into one of the other accounting offices—perhaps freight auditor and into the auditor of equipment account's office, and possibly a little later with one of the engineering parties on the road, and after his year has passed he will be assigned to duties as train master in some locality and one of the other train masters taken into the same class of work.

We want you to all take this plan back with you and pass it along down to the employees. We want everybody to avail themselves of the opportunities that are offered here, and we believe that through you it can be made a success and can be made to help you all in your work.

W. L. PARK,
General Superintendent.

Approved:
A. L. MOHLER,
Vice-President and General Manager.

It will be noted that the plan is to make a sort of clearing house of information with which the humblest employee can have relations by which he may be stimulated, and through which he may widen his view, enhance his efficiency for his present position or for that next in line, and perhaps prepare himself for any job he may select which may not be in the regular line of promotion with his present work. If not already contemplated, it is possible that the student can here be measured up, and have a registry made of those measurements that would indicate his efficiency for any job in the service, and thus put himself on the list of eligibles as openings occur.

By calling it a bureau of information rather than of education an informal character is preserved which invites perhaps more freely the first advances of a diffident constituency. Such a department properly administered is in a way to supply the place of that personal relation which enables the awkward, backward, ill-fitted, or misfitted to make the adjustments to an environment abstractly described in a lot of inexorable rules designed to define the average situation for the average man. Some substitute of this kind the railroads must discover to take the place of the old personal relation which can not now be restored to quite the degree known to the earlier railroader when the operating units were so much smaller. From the standpoint of the railroad, such an agency as this offers the chance for the elasticity in the organization so often lacking to the great loss of its efficiency.

Apparently this machinery is also used by the railroad for recruiting purposes, and here its usefulness is equally large.

XI. HIGHER EDUCATION FOR RAILROAD CAREERS.

The adaptation of higher education to the common uses of life is of comparatively recent date. It is not generally known that the first degree of civil engineer in any English-speaking country was that bestowed upon the members of the graduating class of Troy University in 1835—less than seventy-five years ago—and several decades elapsed before the mechanical, electrical, mining, and chemical engineers were evolved.

The early college courses, leading to the degrees of bachelor of arts and bachelor of science, were intended to be purely cultural—providing a man with the power to think clearly, but giving him no specific application of this power to any particular vocation. There was so great a hiatus between the mere ability to "think straight" and the equipment for a business career that the acquirements of a college training could not be easily traced over into the area of results. The college man was counted theoretical, and his natural awkwardness in the early stages of entering upon practical work was taken advantage of by the man already in harness, who resented the competition of the newcomer. It was only the exceptional man who could overcome this unnatural handicap, and at his mature age adjust himself to the uninteresting routine of the office boy and apprentice. This transition the noncollege man had made already on a basis of full equality with his fellows in his early teens. The effort was all the more discouraging because the college graduate was met at every turn by the universal prediction of ultimate failure. The college man who really entered successfully on a railroad career was generally one who enjoyed some personal relations with the management—relations that effected the adjustment between the college life and the practical world, for which there was no regular provision in the railroad organization. In such cases how much of the aspirant's success was explicable on the ground of favoritism and how much lay in the inherent superiority of the college man was hard to determine, and the advantages of the college courses were as far from vindication as ever.

The deadlock between the so-called "theoretical" and the "practical" naturally was first broken by the engineering school. The problems of railroad construction became so complex that they called into play scientific method. The rule-of-thumb man could use only a limited number of formulæ successfully, and could evolve no new ones. He built his locomotives and his bridges on the "cut and try" plan, and evolved a practice which, more or less accurately, met the conditions with which he dealt. But the factor of guess or uncertainty was far too great. No modern bridge nor latter-day locomotive could be built by such indefinite rules. Mathematics,

mechanics, descriptive geometry, and scientifically evolved formulæ of strength of material became necessary tools for the engineer and master mechanic. The engineering school equipped the man with these tools, and in the technical departments of the railroads this man came to be absorbed into the service. By slow stages shop and railroad construction practice were reduced to statement and exact formulæ, and were related to underlying general principles. Exactly stated fact took the place of opinion, and drawings to scale with supporting formulæ were relied on instead of working models alone. Engineering associations were formed where practice was compared, a current literature was evolved, whereby studies and discussions in scientific terms were disseminated. Almost unconsciously the "practical" man adopted the language and scientific method of the "theoretical" man; locomotives were no longer rated in cars but in tractive force; bridge stresses were reduced to exact computation; the templet of rail was scientifically evolved; the coal that was burned on the locomotives was computed in heat units; the water that was used on the locomotives was analyzed by a chemist; exactness took the place of inexactness; general terms took the place of local terms. Under these circumstances the properly trained graduate of the engineering school has become the "practical" man, and the untrained man the "theoretical." The railroad has taken over the laboratory, the literature, and the method of the technical school. In this way the transition of the graduate from the technical school to the technical departments of railroad service has become easy.

THE TECHNICAL SCHOOL.

The technical school is now a well-recognized adjunct of practical railroad operation. The branches which specifically apply to railroad usage are those of civil, mechanical, and electrical engineering. These courses each occupy not less than four years. In most of the schools the first and second years of the courses are practically the same for all three departments, the theory being that the broadly equipped engineer should have thorough grounding in general engineering principles, so that he can follow intelligently at least the practice in fields of engineering other than his specialty. Thus, a groundwork in the elementary theory of physics, chemistry, and electricity is generally given, reenforced by more or less laboratory work and by a full equipment in advanced mathematics, to enable the student to evolve and use mathematical formulæ. To these subjects are variously added—for the civil engineer—astronomy, geology, mineralogy, and like studies, and for the mechanical engineer, metallurgy. A general technique is usually acquired by some exercise in drawing, shop practice, and experimental method. In some colleges,

as at Cincinnati, land surveying is required of students in mechanical as well as civil engineering.

In addition to what we have called general or grounding studies—giving elementary insight into coordinate engineering departments and an elementary knowledge of the sciences, and which together enable an engineer to relate his own department to other fields and to have a reading knowledge of their practice—is a range of studies more or less cultural, but in a broad sense special to the vocation, which for convenience we will call vocational-cultural. Such, for instance, are special courses in economics, patent law, modern languages, especially English, with a view to public speaking and correct writing, as at Stevens. The theory of such studies is to add to the strictly technical subjects of any given branch of engineering other studies that are intended to be disciplinary, and also those which give a kind of business and social outlook. At Cornell, for instance, a course in political economy (three lectures per week) emphasizes the "economical value of the civil engineer as a director of industrial enterprises and his rôle in the industrial development of the country."

At Stevens Institute of Technology, in the senior year of the course leading to the degree of mechanical engineer, the following studies are taken up by means of lectures and recitations: Commercial limitations of engineering practice—an effort to impress the fact that the engineer must work in conformity with commercial conditions, and by means of established business methods; the principles of accounting; depreciation; shop cost; analysis of data; contracts, and the law governing these, etc. But the courses are for the most part very limited in this direction. The technological schools, generally speaking, include more vocational-cultural studies than do the engineering colleges of the universities, evidently recognizing that their students are less likely to have prepared for specialization in engineering by a previous academic course, and hence stand in greater need of training along lines broadening to the general intelligence. But even among the technological schools, such studies are frequently limited to work in English (argumentation emphasized) and modern languages, with occasional excursions into the realm of political science and economics—as at the Worcester Polytechnic and elsewhere. Armour Institute is exceptional in the number and quality of generally cultural subjects offered, its aim being specifically to afford young men "an opportunity to secure a liberal education." Besides modern-language work with special emphasis upon English, the list of the cultural studies at Armour includes political science, history of recent times, economics, business law, logic, psychology, and the philosophy of the inductive sciences. Special work in English literature and in the history of civilization is offered as electives to all students of engineering.

The method of instruction pursued in all such institutions is the text-book, the syllabus, the lecture course, the reading syllabus, the recitation and quiz, the laboratory, and the school shop. The subjects are presented to the student in orderly sequence that he may get an intellectual grasp of them, and this he converts to practical apprehension by testing out practically, in laboratory and school shop, the principles enunciated in the class room. This method is followed in order to accelerate the work; but to avoid making a mere unthinking student who has acquired things by rote irregularly through the course, the method is reversed, and the student is thrown upon his own resources, to evolve out of practice here and there the principles of practice and enunciate the theory. In this way he does not become stale.

To the school work proper are added inspection tours to operating plants, cessional and special lectures by practical men, giving something of the atmosphere of routine work, apprenticeship courses, etc. The students are encouraged to read technical magazines, the discussions of technical bodies, and to have their own discussions.

UNIVERSITY OF CINCINNATI COOPERATIVE COURSE.

The University of Cincinnati has inaugurated an entirely new departure in university work by the combination of the theoretical and practical in a unique way. They call it the cooperative engineering course. Students taking this course, subject to the supervision of the mechanical engineering department faculty, are regularly employed in the industries of the city, under an arrangement whereby they spend alternate periods in the shop and in the class room. The practical work, as well as the theoretical work, is carefully planned in advance, the dean and the professors conferring with the employer. This course has been expanded from four to six years.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—OUTLINE OF COURSES.

A fair sample of standard technical courses in civil, mechanical, and electrical engineering is offered by those at the Massachusetts Institute of Technology.

FIRST YEAR.

[Common to several courses.]

First term (common to all courses).—Mathematics, plane trigonometry, inorganic chemistry, descriptive geometry, mechanical drawing, free-hand drawing, French, rhetoric, and English composition, military science, physical training.

Second term (common to civil, mechanical, and electrical engineering courses).—Mathematics, inorganic chemistry, descriptive geometry, mechanical drawing, free-hand drawing, French, English, United States history, military science, physical training.

Civil engineering.

FIRST YEAR. (See above.)

SECOND YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Surveying and plotting	90	Surveying and plotting	75
Mathematics	45	Topographical drawing	30
Spherical trigonometry	10	Mathematics	45
Physics: Mechanics, wave motion, electricity	75	Physics: Electricity, optics	75
Mechanism	30	Physical laboratory	30
Descriptive geometry	60	Applied mechanics	45
English literature	30	Stereotomy	60
European history	30	English literature	30

[Summer reading.]

THIRD YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Railroad engineering: Fieldwork and drawing	90	Railroad engineering: Fieldwork and drawing	105
Highway engineering	15	Advanced surveying	30
Advanced surveying	30	Astronomy and geodesy	45
Dynamical geology	30	Theory of structures	45
Structural and field geology	30	Materials	30
Physics: Heat	15	Building stones and lithology	30
Physical laboratory	15	Stratigraphic geology	15
Dynamo-electric machinery	30	Testing materials	30
Applied mechanics	60	Business law	15
Political economy	45	General studies	75
General studies	45		

FOURTH YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Theory of structures: Bridges and similar structures	45	Theory of structures: Bridges and similar structures	45
Bridge design	90	Advanced structures	30
Foundations	15	Bridge design	90
Theoretical hydraulics	45	Steam engineering	45
Steam engineering	45	Hydraulic laboratory	15
Engineering laboratory	15	Thesis.	
Options.		*Options.*	
1. Sanitary and hydraulic engineering	60	1. Hydraulic engineering	45
1. Hydraulic measurements	20	1. Hydraulic and sanitary designing	30
2. Railroad engineering	30	1. Sanitary science and public health	15
2. Railroad designing	60	2. Railroad engineering	45
		2. Railroad designing	30

Mechanical engineering.

FIRST YEAR. (See above.)

SECOND YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Carpentry and wood turning	60	Applied mechanics	45
Descriptive geometry	45	English literature	30
Mathematics	45	Mathematics	45
English literature	30	Mechanical-engineering drawing	30
European history	30	Mechanism and valve gears	45
Mechanical-engineering drawing	90	Pattern work	30
Mechanism	45	Physical laboratory	30
Physics	75	Physics	75
		Precision of measurements	10

[Summer reading.]

Mechanical engineering—Continued.

THIRD YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Applied mechanics	45	Applied mechanics	45
Mathematics	30	Applied-mechanics laboratory	25
Forging	60	Business law	15
General studies	45	Electrical engineering	30
Machine drawing	75	Engineering laboratory	15
Metallurgy of iron	15	Forging; chipping and filing	90
Physical laboratory	15	General studies	75
Physics	15	Heating and ventilation	15
Political economy	45	Mechanical-engineering drawing and boiler drawing	90
Steam engineering: Thermodynamics	45	Use of surveying instruments	
		Steam engineering: Boilers	60

FOURTH YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Applied mechanics	45	Engineering laboratory	60
Machine-tool work	60	Foundations	25
Dynamics of machines	25	Hydraulic motors	30
Electrical-engineering laboratory	30	Industrial management	10
Electrical engineering	20	Machine design	60
Engineering laboratory	60	Machine-tool work	90
Foundry	30	Power plant design	60
Machine design	90	Thesis.	
Theoretical hydraulics	20		
Options.		*Options.*	
1. Marine engineering	25	1. Marine engineering	40
2. Locomotive engineering	25	2. Locomotive construction	40
3. Mill engineering	25	3. Mill engineering and drawing	40
4. Heating and ventilating engineering	25	4. Heating and ventilating engineering	40
5. Steam turbine engineering	25	5. Steam turbine engineering	40

Electrical engineering.

FIRST YEAR. (See above.)

SECOND YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Physics: Mechanics, wave motion, electricity	75	Physics: Electricity, optics	75
Mechanism	45	Physical laboratory: Mechanics, optics	30
Mechanical-engineering drawing	60	Precision of measurements	10
Mathematics	45	Mechanism and valve gears	20
Descriptive geometry	45	Mechanical-engineering drawing	20
Joinery and pattern work or metal turning	60	Surveying	30
German or French [a]	30	Mathematics	45
English literature	15	Power and its transformations	5
European history	30	Applied mechanics	45
		Metal turning or joinery and pattern work	60
		English literature and composition	30

[a] Students continue during this term the language that they studied during the first year.

[Summer reading.]

Electrical engineering—Continued

THIRD YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Physics: Heat	15	Elements of electrical engineering	15
Physical laboratory: Heat	15	Electrical engineering laboratory	45
Elements of electrical engineering	60	Alternating currents	45
Electrical measuring instruments and methods	10	Technical electrical measurements	30
Electrical laboratory	15	Standardizing laboratory and electrical laboratory	50
Steam engineering: Thermodynamics	30	Steam engineering	60
Mathematics	30	Machine drawing	60
Applied mechanics	45	Mechanical-engineering laboratory	20
Political economy	45	Business law	15
General studies	45	General studies	75

FOURTH YEAR.

First term.	Hours of exercise.	Second term.	Hours of exercise.
Alternating-current machinery	45	Alternating-current machinery	45
Electrical-engineering laboratory and reports	80	Electrical-engineering laboratory and reports	40
Electrical light and transmission of power	30	Engineering laboratory	45
Journal meetings and excursions	30	Stationary structures	45
Technical electrical measurements and standardizing laboratory	40	Hydraulic engineering	30
Theoretical hydraulics	30	Thesis	90 to 150
Engineering laboratory	45	Optional studies	120 to 170
Economics of corporations	30		
Thesis	45		
Optional studies	30		

Massachusetts Institute of Technology is conspicuous for the number of successful railroad men who are among its graduates. President Tuttle, of the Boston and Maine Railroad, is credited with the view that the work there done is sufficiently specialized to railroads for practical purposes, and he therefore is not among the number who urge a special railroad engineering school. The specialization for railroad work offered at the Massachusetts Institute of Technology is as follows:

Department of Civil Engineering.

Railroad engineering.—This course consists of a thorough study of curves and earthwork and their application in location and construction. The first term is devoted to the mathematics of curves, with applications to the location of railroads, highways, sewers, pipe lines, etc. The second term is devoted principally to the methods of staking out and computing earthwork. Recitation work predominates, particularly in the first term, and many problems are assigned for solution outside and in the class room. The applications of this course are further enforced by the following course.

Railroad drawing and field work.—In the first term a survey is made for a railroad some 2 miles in length. The reconnaissance is followed by the preliminary survey and the location, and the work is conducted according to the methods of modern practice in laying out railroads. Upon the completion of the field work the line is plotted from the notes taken. In the second term, the field work consists in laying out curves of various kinds and in staking out earthwork; while the drawing consists in the construction of the profile of the line surveyed, and of practice in adjusting a line of rail-

road upon a contour map, with computation of the earthwork and the preparation of a "mass diagram" for the determination of questions of "haul" and of "borrow and waste."

Railroad and highway designing.—A course, including problems in contour location; the proportioning of culverts and waterways; the design of track work, yards, station grounds, interlocking signals, and other practical railroad problems involving the application of principles. Each student is given a different problem to solve, and the work is critically corrected and discussed in detail.

A further course in railroad engineering, given in the fourth year, considers maintenance of way; the economics of railroad location, with a critical study of train resistance, and the influence of grade, distance, curvature, and rise and fall; rolling stock and motive power brakes; signals; yards and stations; tunnels, and street railroads. The object is to give the student a comprehensive knowledge of railroad and street-railway engineering.

Special attention is given in another fourth-year course to questions of economics in the various operations which arise in the construction and operation of railroads.

Department of Economics and Statistics.

Economics of corporations.—A course treating of the nature of corporations and their legal development, accounting, valuation of bonds, holding companies, lighting companies, street-railway franchises, and the taxation of corporations.

Railroad economics.—Lectures and recitations and special investigations under the supervision of the instructor. The method employed is both historical and comparative, and each question is discussed, so far as practicable, in the light of European as well as American experience. The following are some of the topics covered: The history of railroad development in the United States, methods of financing new roads, character and cost of construction in different countries, competition and combinations, public service, rates and fares, freight classification, methods of accounting, reports and statistics. Special attention is given to the relation of the railroads to the State, and students are encouraged to investigate problems connected with government regulation and control.

Department of Mechanical Engineering.

Locomotive engineering.—Lectures and recitations. The option in locomotive construction begins with a careful study of the form and proportions of the details of the more usual types of locomotives. Sets of complete detail drawings of modern locomotives, both simple and compound, are used for this purpose, a considerable number of such drawings having been furnished to the department by different locomotive builders. While most of these are American, nevertheless consideration is given also to those of foreign construction. The students make calculations of the stresses to which the various parts are subjected, and thus learn to determine the strength of the different members, modern locomotives being used for this purpose. A study is made, also, in some detail, of the compound locomotive, of train resistance, of air brakes, of heating cars by steam from the locomotive, of the modes of conducting locomotive tests, of the economy and performance of both simple and compound locomotives, as shown by tests, etc.

Department of Electrical Engineering.

Electric railways.—A course of 30 lectures and quizzes in the second term of the fourth year, including a discussion of the construction, equipment, and operation of different types of electric roads, together with related problems in power transmission and the mechanical engineering of electric power stations.

Organization and administration of public-service companies.—Three hours of lectures or conference per week through the year, accompanied by extensive assigned reading and examination of operating records. The course treats of the relations of public-service companies to the governments and to the people, the methods of organizing public-service companies and the legitimate expenses entering into the cost of organization, their management viewed especially from the commercial aspect, and the legitimate functions of such companies. Certain aspects of the subject are discussed by the department of economics, particularly from the point of view of public interest.

At Cornell and Purdue universities the specialization in civil, mechanical, and electrical railway engineering courses is carried further. At Cornell specialization for railroad purposes takes the following form:

CORNELL UNIVERSITY—OUTLINE OF COURSES.

Railroad Engineering (College of Civil Engineering).

Field work includes laying out of curves, turn-outs, etc., and the staking out of structures in addition to making the reconnaissance and the preliminary and location surveys for about 5 miles of railway in the Inlet Valley. Work cross sectioned and position of structures determined. Drawing map, profile, and plan of structures. Earthwork computed from cross sections. Estimates on quantities, costs, etc. Recitations and lectures take up field problems, computation and cost of earthwork, subgrade and track structures, track work, economics of railway location and operation.

Railroad maintenance of way.—Construction and maintenance of track and accessory structure, gradients, and alignment. Design and maintenance of yards and terminals.

Railroad operation and management.—Organization. Relation of management and operating departments to construction and maintenance. Block signaling and interlocking. Rapid transit.

Railroad construction and maintenance.—Economics of location and construction, with construction, strength, and durability of track structures. Maintenance and operation.

Department of Railway Mechanical Engineering (Sibley College of Mechanical Engineering).

Courses have special relation to design, manufacture, service in operation, repairing and trials of locomotives and other rolling stock and their equipment, and with the problems of other kinds of machinery in railway operation. Designed especially for young engineers trying for mechanical departments of railroads, and positions, ultimately, of superintendents of shops and motive power. Also for locomotive and car builders, managers of "contract shops," for the railway supply business, as mechanical engineer, superintendent of works, traveling agent for supply and manufacturing firms.

Locomotive shopwork.—At least one summer's work in constructing or repairing locomotives is considered necessary previous to the railway senior year. Shops for the above are situated in all sections of the country. Satisfactory examinations, however, will be accepted in place of shopwork.

Railway machinery (first term).—Transportation as a whole: History of steam railways. Railways and the business public. Typical roads and systems examined analytically and synthetically. Deductions made.

Railway organization.—Charts of different methods for the analysis of the efficiency of same. Duties and relations of the several general and special departments. Influence of methods and aims of one department on another.

Mechanical department.—Scope, personnel, duties, and methods. Specialized subdivisions. Larger problems and the future. Opportunity of electric traction. Locomotive and car repair shops and locomotive terminals.

Locomotives (second term).—Designing, manufacture, testing, repair, etc., of locomotives, tenders, cars, and accessories. A special study of the locomotive.

Designing.—Problems adapted to future work of student and made practical. Several thousand railway blueprints in use.

Railway club.—Special papers and reports.

Locomotive testing.—Instruction tests of engines in use (courtesy of Delaware, Lackawanna and Western Railroad).

Locomotive engineering.—General principles of all locomotive designing. Types. Maximum hauling efficiency, minimum expense, etc.

In the department of electrical engineering the following groups of subjects have special bearing upon training for railroad service:

Elements of electric-railway practice (elective).—Lectures on apparatus and construction involved in electrical railway systems, i. e., car equipment, trucks, motors, controllers, bodies, and accessories, overhead construction, third rail, conduit, etc. (Course applies general laws of electrical engineering to railways.) Relation of electric railways to public and finance.

Electric railways.—Lectures. Theory of train movement—characteristic curves of railway operation. Practice in plotting time-speed curves, motor-heating curves, railway-load curves, drop in transmission lines, etc. Inspections of local equipment of power house and substation, track and overhead construction, construction of cars, administration of car barns, etc., of local railway.

At Cornell University, in connection with the mechanical engineering department, arrangements are made with the railroads whereby about 30 shops are open each summer to the students for three months' work. The wages more than cover the expenses, and some 60 to 80 students annually avail themselves of the opportunity offered. The instructors urge this work because it develops character and self-reliance and better class standing.

PURDUE UNIVERSITY.

In a similar way with Cornell, Purdue University has highly developed railroad mechanical engineering and civil engineering courses. It adds to its specialization for railroad work a very elaborate railroad museum and testing plant, which has been conducted for the uses of the university and for research work in conjunction with certain of the railway mechanical associations. Because of this expert service, and because it has become especially strong in the personnel of its department of railroad mechanical engineering, Purdue has been one of the first institutions to develop an intimate relation with practical railroad men, and a large number of its graduates have successfully entered railroad service.

XII. SCHOOLS OF RAILROAD ENGINEERING AND ADMINISTRATION.

In differentiating the work done which is specialized to railroads we have noted the successive concessions by the civil, mechanical, and electrical engineering departments to railroad needs. In this way has been evolved a railroad specialty in civil, mechanical, and electrical engineering, but merely as a specialty or phase of the broader field of engineering when it occurs. Such work leads, of course, to the degree of mechanical engineer, civil engineer, or electrical engineer.

UNIVERSITY OF ILLINOIS—ADMINISTRATIVE AND ENGINEERING COURSES.

The technical graduate has been found, in railroad practice, to have devoted too much of his time to merely engineering problems. His practical work in life involves organization, administrative methods, and highly complex sociological problems. The weak point in railroad operation has not been lack of technical skill, but administrative inefficiency. Quoting from the bulletin of the University of Illinois:

> In railway work, as in other fields, one is seldom selected for an administrative position solely because of his technical professional attainments. His promotion depends rather upon his ability to grasp and properly evaluate all phases—financial, technical, and economic—of the problems presented for his solution. The effort is therefore made to emphasize this point of view and to stimulate interest in these directions, not only by the method of presenting the technical work but by the incorporation of other than purely technical subjects in these courses. Toward this end there is included, for example, among other general subjects in the engineering courses, such work as economics.

The result of this has been a recent departure in the organization of the university work. At the University of Illinois, for instance, and also at McGill University the engineering courses, with a special railway transportation course, are gathered into a railroad department. In the case of the University of Illinois we quote again from the bulletin:

> Since 1900 the college of engineering of the University of Illinois has offered a course in railway mechanical engineering and has carried on experimental work relating to steam-railway practice. In 1906, in fuller recognition of the needs of training for railway service, there was established a school of railway engineering and administration whose function it is to coordinate the various facilities of the university so as to provide specialized training for all branches of railway service and otherwise to further this work. In developing this plan there was created in the college of engineering a new department of railway engineering; and the department of economics of the college of literature and arts has added to its courses of business administration courses in railway traffic and accounting and in railway transportation.
>
> It is the purpose of the school of railway engineering and administration to provide training which shall prepare men to become efficient workers in the financial, traffic, and operating departments, as well as in the engineering departments, of both steam and electric railways.

The first effect of such coordination of subjects is to give to the railroad engineering work more distinctly the quality of a railroad course, and next, very naturally, to suggest the possibility of a purely administrative railroad course "with enough of technical engineering work to give an understanding of the problems arising in the engineering department."

Quoting again:

In modifying the regular engineering courses to make the new railway engineering courses, care has been taken not to sacrifice any of the time devoted to the study of the fundamental sciences. Changes have been made simply by substituting for some of the special technical work of the last year other special railway subjects of equal educational value, but of such a nature as to introduce the student to some of the problems later to be encountered in practical railway work. The railway engineering courses are therefore but little more specialized than the regular engineering courses. Students who successfully complete the railway engineering courses receive the degree of B. S. in either railway, civil, electrical, or mechanical engineering.

Railway administration.—The courses in railway traffic and accounting and in railway transportation aim to prepare men for service in all departments of railway work other than the engineering and legal. Each course is four years in length and is framed so as to give wide knowledge and training in the specific matters which relate to the organization and operation of all departments of railway administration, while at the same time giving the student a liberal education.

The course in traffic and accounting may be considered the general course in railway administration, in which the student without any special predilection for the operating service of the railway will naturally register. A sound knowledge of the fundamentals of political economy and finance is insisted upon in this course, while the student is also familiarized with the leading features of modern industrial and commercial organization. An adequate training in cost and industrial accounting, trustee and railroad accounting, and auditing is required. The course in transportation, while still demanding considerable economic training, includes certain courses of the college of engineering. Theoretical and applied mechanics, based upon two years' work in university mathematics, forms an important part of this technological work. Short elementary courses in steam engineering, surveying, and graphic statics are included. This work is by no means intended as a training in engineering, but aims at giving the student some acquaintance with general principles underlying the work of the maintenance of way and motive power departments. Trainmasters and division superintendents, men not necessarily trained engineers, will be able to discharge their duties all the more efficiently by reason of such training. Thirteen semester hours in physics and chemistry also form part of the requirements of the course.

The special railway work of both the traffic and accounting and the transportation courses commences, in the first semester of the third year, with the history of the development of the railway system of the United States, with which is associated for the present a review of the present methods of internal organization. This is followed by a course upon important economic problems connected with railway finance, traffic, and political relationship, and the training thus obtained is made use of in studying intensively the railway situation in some foreign country. Concurrently with these courses the student takes up in class the study of the organization and methods of the freight and passenger traffic departments and of the operating department. In his senior year each student is required to give special attention to some particular problem of railway policy or operation, embodying his work in the form of

a thesis. In the course in transportation the student is furthermore required to take a course on locomotives and one on railway tests.

Students successfully completing the course in railway traffic and accounting or in railway transportation will be granted the degree of A. B. in railway administration. [This is a new degree.]

McGILL UNIVERSITY—SCHOOL OF TRANSPORTATION.

At McGill University, in Montreal, there has been established, as at the University of Illinois, a school of transportation, in which are grouped the several railroad engineering courses. The head of the department is a former mechanical engineer of the Boston and Maine Railroad. His policy is to supplement the work of the regular teaching staff by sessional lectures on the operating, accounting, and traffic side. Students are expected to work with the railroads in the summer months, and they plan to continue with the Grand Trunk or the Canadian Pacific Railroad Company (which are the special patrons of the course) after graduation. The courses for the various engineering degrees are practically the same for the first two years, and the specialization is made in the third and fourth years. The particular departure is in the course looking to service in the operating or executive department.

McGill University.

APPLIED SCIENCE.

First year.

Algebra.	Lettering.
Descriptive geometry.	Physics.
Dynamics.	Physical laboratory.
English.	Shop work.
Free-hand drawing.	Trigonometry.
Geometry.	Surveying, field work.

Second year.

Analytic geometry.	Mechanics.
Calculus.	Mechanics of machines.
Chemistry.	Physics.
Chemical laboratory.	Physical laboratory.
Mapping.	Shop work.
Materials of construction.	Surveying.
Mechanical drawing.	Surveying, field work.

Third year—Department of railways.

Subject.	Lectures per week.		Laboratory, etc., periods per week.	
	First term.	Second term.	First term.	Second term.
Economics	2	2		
Engineering law	1	1		
English	2	2		
Freight service		2		
Masonry and foundations			1	
Organization and accounting	1	1		
Railway engineering	2	2	1	1
Strength of materials	2	2		1
Structural engineering		1		1
Shorthand	2	2		
Telegraphy			1	1
Surveying, field work				

Fourth year—Department of railways.

Subject.	Lectures per week.		Laboratory, etc., periods per week.	
	First term.	Second term.	First term.	Second term.
Accounting	1	1		
Economics	2	2		
Electrical engineering and laboratory	2	2	1	1
English	1	1		
Freight service		1		
Operating	2	2		
Passenger service		1		
Physical geography and climatology	1	1		
Railway engineering	2	2		
Railway law	2			
Railway mechanical engineering	2	2	1	1
Signals	1	1	1	1
Shorthand	2	2	1	
Telegraphy			1	1

Third Year (Operating and Executive).

Economics.—Economic theory, with special reference to the organization of modern commerce and industry, railways and their development, essay writing, the preparation of reports, and discussion of practical problems.

Engineering law.—This course is intended to present such an outline of the law as will be useful to engineers and business men. Among the main topics may be mentioned the general law of contracts; commercial paper; sale, lease; agency and partnership; joint-stock companies; insurance; and carriers by land and sea.

English.—The preparation and criticism of reports on stated subjects, the object being to acquire a clear and accurate style.

Foundations and masonry.—Borings; bearing power of soils; piles and pile driving, concrete piles; footings; grillages; underpinning; foundations under water; coffer dam, open dredging, pneumatic and freezing processes; estimation of quantities from drawings; estimates of cost. Strength of materials must be taken concurrently, or the student must have equivalent preparation.

Freight service.—Freight department organization, records, and statistics—a full explanation of the methods of handling freight.

Mechanical engineering laboratory.—Experiments relative to the pressure and temperature of saturated steam, gauge testing, valve setting, trials upon steam engine, air compressor, steam pumps, and gas engine, boiler trials, and air-brake work. This course is supplemented by visits to power plants and locomotive shops.

Railway engineering.—History of Canadian railways; the railway act of 1903; the conditions governing projected railway lines; the railway corporation; effect of location on volume of traffic; estimate of probable traffic; economic consideration of distance, curvature, and grade; relative importance of grades; train resistance; equipment; limiting grades and curvature; trunk and branch lines; the reconnaissance for route; organization and equipment; maps and office work; location; curves; virtual profile, maximum grades; ruling grades; rise and fall; cross sections; estimates and computation of quantities; comparison and capitalization of two lines; cost of surveys; construction; earthworks; form of excavations and embankments; earthwork surveys; computation of volume; formation of embankments; computation of haul; cost of earthwork; trestles; pile and framed trestles; floor systems; openings; culverts and minor bridges; ballast; rail; rail fastenings; ties; switches and crossings; switch construction; mathematics of switch design; miscellaneous structures; yards and terminals; drafting from notes; the paper location of a railway; maps and profiles; earthwork diagrams; switch design; yard design.

Railway mechanical engineering.—Elementary course on the steam engine, steam boilers, power-plant equipment, steam turbines, gas engines, compressed air, and elementary locomotive construction and operation.

Railway organization and elements of accounting.—Organization and work of the various departments; duties of officers; accounting.

Strength of materials.—This course deals with the fundamental principles of the strength of materials. It includes the following: Stress, strain, resilience, and the elastic properties of materials used in construction; bending moment and shearing force diagrams; strength, curvature, and deflection of beams; continuous beams, cantilever beams, and the like; simple problems on rolling loads; the strength of shafting; spiral springs; bending combined with tension or compression; elementary consideration of compound stresses; distribution of shearing stress on various sections, etc.

Structural engineering.—Problems in the design of beams, plate girders, columns, roof trusses, knee bracing, etc.; working drawings; reenforced concrete; estimates of quantities; estimates of cost.

Shorthand.

Telegraphy.

Fourth year (Operating and Executive).

Accounting.—The principles of accounting, a development of the course of the third year. Earnings and expenses; shop material and cost; labor and methods of paying for same; statements, their nature and value.

Economics.—Transportation economics, including the theory of railway rates, railway commissions, taxation of railways, government ownership and control, the treatment of transportation problems in Europe and America, etc. Attention will be paid to questions closely connected with transportation in Canada, such as the relative powers of the Dominion and Provincial governments, the tariff, immigration, government aid to railways, public lands and immigration. Essays connected with the above questions will be required.

Electrical engineering.—Laboratory for third-year students in mechanical engineering and fourth-year students in civil and mining engineering and transportation. Includes tests of direct-current metering and controlling devices, dynamos, motors, boosters, motor generators, and constant-current machines; experiments on variable current flow in circuits of different kinds; tests of alternators, synchronous motors and converters, induction motors and transformers.

English.—Continuing the work of the third year.

Freight service.—An extension of the work of the third year. This course involves a discussion of the broader problems of the freight-traffic department.

Operation.—Organization of conducting transportation department; the development of train dispatching in America; the development of the control of train movement in Europe; conducting transportation expenses; standard time; the American Railway Association; formation of time tables; standard train rules; rule for movement of trains on single track; rules for trains on double track; general rules covering the operation of trains and handling of freight and passengers; clearance cards and other blanks; station service; yard service; road service; duties of dispatchers and operators.

Signals.—Block signaling; manual systems; automatic systems; estimates and plans.

Interlocking.—Economic considerations; the different forms of mechanical interlocking machines, the locking sheet, dog charts, the lead out, the ground connections, switch and signal connections, the cabin, power machine, electro-pneumatic, all electric costs, interlocking of terminals and yards; electrical apparatus in connection with mechanical machines, construction and maintenance, organization of signal department, records and reports.

Drafting.—Design of crossing lay out; making of locking sheets and dog charts; block-signal location plans; design of switch and signal connections.

Passenger service.—The passenger department—its organization, methods, and general principles governing passenger business; baggage system; mail and express.

Physical geography and climatology.—Geographical subdivisions of the country; mineral areas; timber belts; wheat areas and water powers; irrigation; climatology and its relations to occupations and soil products.

Railway law.—This course is concerned largely with the railway act, and a general outline of the law of common carriers. Special attention will be given to such subjects as expropriation, damage suits against railway companies, and the more usual forms of contracts with carriers.

Railway mechanical engineering.—Locomotive tractive power; train resistance; tonnage rating; locomotive testing; comparative costs of locomotive operation; boiler incrustation; chemical control of water-purifying plants; determination of hardness, acidity, etc.; fuel handling, location, design, equipment, and organization with reference to roundhouses and railway shops; mechanical engineering requirements at terminals.

Railway engineering.—Interlocking; block signaling; records and reports; maintenance of way organization, accounts, and programme for expenditures; track maintenance; tie renewals; ballast renewal; relaying and renewing rails; track tools; work-train service; steam-shovel work.

Electrical railways.—Economic considerations; preliminary surveys; determination of schedules and equipment; details of location; details of construction; power-plant location; organization of operating department; maintenance of track structures.

Shorthand.

Telegraphy.

Shopwork.

Shopwork includes work in the carpenter shop and pattern shop, smith shop, foundry, and machine shop.

The course in shopwork is intended to afford some preparation for that study of workshop practice on a commercial scale which every engineer has to carry out for himself. With this end in view, the student works in the various shops of the department, and completes in each a series of practical exercises. He thus obtains some knowledge of the nature and properties of the various materials he employs; he receives systematic instruction in the use and care of the more important hand and machine tools; and he acquires some manual skill. The instruction thus obtained

must, however, be continued and supplemented. For this purpose students are expected to spend the greater portion of each long vacation in gaining practical experience in engineering workshops outside the university.

One of the sessional lecturers is a general passenger agent. As an illustration of the practical character of his course, we append an excerpt from a set of examination papers:

Passenger Service.

FOURTH YEAR.

First paper.

1. (*a*) From what two sources do railway companies derive their revenue?
   (*b*) Which is the more important of the two from the standpoint of revenue?
   (*c*) Besides revenue directly derived from transporting passengers, what various items of income are usually credited to passenger earnings?
   (*d*) Why is it not practicable to arrive at the net earnings of any railway on passenger traffic?
2. (*a*) What is the officer at the head of the passenger department usually called, and what in a general way are his duties?
   (*b*) Describe the general organization of the passenger department (head office) of a railway.
3. (*a*) What may be considered a prime factor in establishing the rate per mile for passenger traffic?
   (*b*) What is the prevailing rate per mile in Canada?
   (*c*) How are passenger tariffs figured?
   (*d*) What is the difference under the Canadian railway act between a standard and a special passenger tariff?
   (*e*) Wherein do local, interdivision, and joint passenger tariffs differ from each other?
4. (*a*) Describe briefly the "life" of a railway ticket.
   (*b*) What is the difference between a local and a coupon or interline ticket?
   (*c*) What is a "chart of forms?"
   (*d*) What are some of the more important features of the contract of a coupon or interline ticket?
   (*e*) How do railway companies obtain payment from each other for the value of through tickets issued over their lines?
   (*f*) How are passenger rates divided between the different participating lines?
   (*g*) Explain the difference between "pro rata per mile" and "pro rata per rate."
5. (*a*) What are the general principles which govern the making of excursion rates?
   (*b*) How are conventions handled?

Second paper.

1. (*a*) What have the officers of the passenger department to do with the train service and equipment?
   (*b*) What is the general effect of electric railway competition on the passenger business?
2. (*a*) Who usually has charge of the advertising of a railway?
   (*b*) What forms of advertising are most commonly used by the railways?
   (*c*) What are the salient features of an effective advertisement?
   (*d*) How are time-table folders prepared?
3. (*a*) What quantity of baggage is usually carried free with each passenger on this continent?

(*b*) What special allowance do commercial travelers get in Canada, and why none in the United States?
(*c*) What articles are generally classed as baggage?
(*d*) Wherein is the system of handling baggage on this continent better than that followed in England?

4. (*a*) How are ticket agents instructed to comport themselves to the public?
(*b*) Where does the agent find the rates at which he is to sell tickets?
(*c*) What happens to an agent if he charges too little for a ticket.
(*d*) Whence does he obtain his supplies of tickets?

5. (*a*) What are the principal duties of a train conductor so far as the passenger department is concerned?
(*b*) What are the principal duties of a sleeping-car conductor?

XIII. SCHOOLS OF RAILROAD ADMINISTRATION.

In the successive systematization of what we know to useful account, the exact sciences were first laid under contribution. Economic and social phenomena, being inexact sciences, have been held to have only a cultural and indirect value to men of affairs. But certain of the detail and technique of administrative method have from time to time been reduced to statement, and railway engineering courses have been supplemented irregularly in this direction. Now the time has come when this detached detail and this administrative technique are being ordered into systems explained on general principles and related to the sociological and economic studies which hitherto have been considered largely speculative.

Beginning with the draftsman's table and the method of the school in combination, "theory" and "practice," kept in close juxtaposition, have together advanced, as we have seen, to the pure engineering and the technical and special railroad engineering school; and now, completing the cycle, this principle of devoting education to useful account has come around to the regular college course and found use for the data of many of its liberal studies. Like the engineering and technical schools, the latter-day schools of administration must force a respectful recognition from the "practical" man. But because their sciences are inexact, acknowledgment of the schools which would apply such sciences to business must come slowly. The schools of agriculture, which have now established their place in farm practice, floundered many years in experimental courses, which were contemptuously referred to as "book farming." In somewhat the same way the school of railroad administration must feel its way to secure ground.

The admirable work done at the Wharton School of Commerce of the University of Pennsylvania was for a long time the sole effort in this direction. Very recently the movement has taken on extraordinary vigor. Harvard and Yale have only within the past year established such schools.

TUCK SCHOOL OF ADMINISTRATION—DARTMOUTH.

Tuck School, at Dartmouth, which was founded in 1900, was conceived on very liberal lines, and has steadily advanced in efficiency and recognition. Its course and methods will serve as a type of the best schools of this kind.

The bulletin of the school very admirably sets forth the general theory of this latest departure:

> The institutions of higher commercial education present, from the point of view of their organization, two distinct types. One type presents as its commercial course the regular undergraduate college course modified by the introduction of commercial subjects. The principle represented by this type is that training for business may be made part of a liberal cultural training. The other type presents as its commercial course a group of commercial subjects to be taken up by the student after he has completed his liberal training. The principle represented by this type is that training for business should be specialized, professional training, just as training for law or for medicine is specialized and professional, and should follow the college course. The Tuck School is representative of this second type, and presents the following distinguishing characteristics:
>
> First. The school requires for entrance that a student shall have practically completed his liberal college course. This insures a body of students who have experienced the discipline and broadening influence of college life and instruction. The life of the college develops certain characteristics fundamental to a successful career—independence, originality, adaptability; the instruction of the college develops the power to acquire and give value to facts. The school insists that its students shall have been trained as men before it undertakes to train them as business men.
>
> Second. The greater part of the work of the school is of graduate grade. This makes possible, on the part of both students and instructors, a quality of work not attainable in undergraduate instruction. Graduate instruction is characterized in part by more intimate contact between instructors and students and by greater intensity of application on the part of the students.
>
> Third. The organization of the school as a professional school permits instruction in subject-matter directly applicable to the work of a business man. ' Emphasis is laid on the practical. The student is inspired to approach his work with the attitude of mind of the business man rather than that of the theorist. In his study of economics in college the student has become acquainted with the general principles of industrial activity; in the first year of the Tuck School emphasis is laid on the practical aspects of business activity; in the second year of the school the work is strictly technical, and, if the student so elects, specialized.
>
> Organization as a professional school has an important influence on the work of the student in that it encourages the development of a professional spirit. This spirit intensifies the work of the student while in the school and prepares him for immediate adjustment to business life after he has completed his training.

RELATION OF SCHOOL TO COLLEGE.

The Amos Tuck School of Administration and Finance is one of the associated graduate professional schools of Dartmouth College. It offers a two-year course. These two years of Tuck School work follow the four years of college work, but it is so adjusted to it that the first year of the school, requiring for admission three years of college work, is equivalent to the college senior year, while the second year of the school constitutes a fifth year strictly graduate in character.

The Tuck School confers the degree of master of commercial science upon regular students who have completed the work of both years. This is a new degree.

GENERAL AIM.

The school aims to make it possible for young men to begin business careers with the advantages that accompany a disciplined and well-informed mind, a general knowledge of business conditions and methods, and a special knowledge of certain branches of business which have become specialized. The school does not presume to create the genius for business; it aims in this respect to assist the young man to discover for himself and combine into an effective working force such elements of business ability as he may possess. It does not presume to make of its students men of mature business judgment; in this respect it aims to equip its graduates with those powers of analysis and interpretation necessary to the development of sound judgment in business experience. It does not presume to create experts in any particular line of business; it does aim, however, for many branches of business, to acquaint its students with those rudiments of expert knowledge, familiarity with which makes the further acquisition of expert knowledge relatively easy. The school does not expend its energy teaching those details of business which can be learned most quickly and effectively in later experience; it is the purpose, however, to develop for the business world an exceptional grade of raw material possessing the ability to recognize the significance of routine details in their relation to the organization of a business institution.

Increasing division into departments has impaired the efficiency of the customary method of developing managers by experience alone, for the influence of division of labor is to limit the activity of the apprentice to routine functions and to make it increasingly difficult for him to acquire a comprehension of the larger aspects of a business. The method of an earlier generation, of setting an untrained man to the performance of general utility services, and thereby making of him an efficient manager, does not suffice for modern business concerns. This process of developing managers must be improved by the substitution of trained for untrained apprentices.

Young men recognize, from the point of view of their interests, at least four significant advantages to be derived from such training:

First. The organized institution of commercial education serves as a medium for introducing them into the service of business firms. The graduate of an institution which has acquired the reputation of offering efficient training, and of exercising care in its recommendations, is looked upon with favor by firms demanding capable apprentices. In performing this service the institution acts as a selective force, bringing together individuals and businesses adapted to each other.

Second. They recognize the advantage, in competition with fellow-employees, of beginning service with a previously acquired knowledge of the technical aspects of a business.

Third. They recognize the special advantage to be derived, in competition for advancement, from an ability to look out over the walls of a department and comprehend the business as a whole, the relation of its parts, and its relation to other business.

Fourth. If the business is one requiring expert knowledge, such as the conduct of foreign exchange, for one to enter the business with that expert knowledge already in part acquired gives one great advantage over fellow-employees who do not possess that knowledge.

Outline of the Transportation Course.

(By semesters.)

Accounting A.
French A, German A, or Spanish A.
National industrial efficiency.
Economic geography.
Statistics A.
Money and banking.
Industrial organization.

Accounting B.
French B, German B, or Spanish B.
Resources and industries of the United States.
Statistics B.
Commercial history and policy.
Transportation.
Interstate commerce act.

Accounting C.
French C, German C, or Spanish C.
Commercial law A.
Corporation finance A.
Business management.
Railroad service.
Thesis: Transportation.

Accounting D.
French D, German D, or Spanish D.
Commercial law B.
Corporation finance B.
Thesis: Transportation.

Description of Work in the Separate Subjects.

ACCOUNTING AND AUDITING.

FIRST YEAR.

A. *Theory of accounting.*

The work of this course is designed to afford the student a knowledge of the terminology and general principles of the science of accounting. The application of these principles to the elements of a business concern is illustrated by problems. Practice is given in the interpretation of financial statements. Lectures, collateral readings, and reports.

B. *Accounting practice.*

The accounts pertaining to several typical forms of business are conducted to acquaint the student with the technical methods of accounting practice. Special attention is given to the modern forms of principal and auxiliary books of account. Practice in the construction of financial statements is provided.

SECOND YEAR.

C. *Advanced accounting and auditing: Practice and analysis.*

(*a*) Accounting practice: Illustrating the legal and economic aspects of accounting practice; the conservation of capital, the apportionment of income, the determination of profits, etc.; definitions and forms of accounts; standardization in accounting.

(*b*) Analysis of accounts: Exposition of the objects and methods of analysis, supplemented by the solution of problems.

(*c*) Auditing: Theory and practice of auditing; the duties of the auditor, his qualifications and the scope of his work; practical problems.

D. *Special studies in accounting.*

A group of courses, each designed to meet the needs of the student preparing to enter a particular business.

(*a*) Cost accounts: Theory and practice; for students specializing in manufacturing or general business.

(*b*) Investment accounts: Methods of accounting for interest-bearing securities.

(*c*) Railroad accounts, for students preparing for railroad service.

(*d*) Bank accounts, for those preparing for banking.

(e) Accounting methods employed in other lines of business will be taken up when desired.

The devising of systems of accounts by the student is a feature of the general course.

MODERN LANGUAGES.

These courses aim to increase the student's knowledge of the grammatical structure of the language and his knowledge of the common idioms; to familiarize him in particular with the vocabulary and the idioms of trade and commerce; to enable him to make use of the trade, commercial, and financial periodicals of the language; and to give him practice in the writing of business letters, documents, advertisements, and catalogues.

STATISTICS.

FIRST YEAR.

A. *Elementary statistics.*

The history, theory, bibliography, and elementary methods of statistics. Statistics of prices, wages, family budgets, public finance, and so on; the graphic method as an aid in the presentation of results; the collection and tabulation of statistical data. Lectures, text-books, and assigned problems.

B. *Advanced statistics.*

A course in advanced statistical methods, illustrated by wage, price, financial, industrial, and insurance statistics; frequency curves; the normal curve of distribution; correlation; interpolation; probable errors; curve smoothing; accuracy, and so on. Lectures, assigned readings, and reports. One session each week will be a two-hour laboratory period.

LAW.

SECOND YEAR.

A and B. *Commercial law.*

An outline of the main principles of the law of contracts; agency; bailments, including the obligations of common carriers and telegraph companies; bankruptcy and insolvency; insurance; negotiable instruments; partnerships, joint-stock companies, and corporations; the acquisition and transfer of property, and sales of personal property.

BUSINESS PROCEDURE AND ADMINISTRATION.

FIRST YEAR.

A. *Theory of business administration.*

A consideration of the elements of a business, with especial reference to a comparison with the points of view of the business man and the economist; a survey of the functions and operations of the various classes of business; the problems of business management, such as the conservation of capital, the proportioning and organizing of factors, and so on; the interrelations of business concerns, with special reference to instruments employed.

SECOND YEAR.

B. *Business management.*

(a) A correlation, with special reference to business management, of the most important principles of economics, private finance, and accounting. Production; wages and conditions of efficient labor; interest; functions and qualifications of the enterpriser; profits; fixed and variable expenses of production; loan capital and the turnover; time-saving processes and the turnover; theory and methods of advertising.

(*b*) Organization: The plant as related to the business; typical organizations of different forms of business; the interrelations of the personnel of the business force.

(*c*) System: Systems whose object is efficient routine; systems whose object is the collection of statistical records. Details of system; buying; storing; records of materials in process; records of labor; records of work and depreciation of machines; advertising, selling, and the sales force; credit and collections.

CORPORATE ORGANIZATION AND ADMINISTRATION.

FIRST YEAR.

A. *Industrial organization.*

Historical development and analysis of the different forms of industrial organization, including the partnership, joint-stock company, and the corporation, and the later developments, such as the pool, trust, combination, and holding company. Critical discussion of the advantages and disadvantages of recent forms of business organization, illustrated by documents. Elements of the law of corporations, with special reference to organization and management. The evils of corporate organization, such as fraudulent promotion, overcapitalization, and manipulation. Public policy toward corporations, with special reference to taxation. Commerce clause of the Federal Constitution and its growing importance.

SECOND YEAR.

B. *Corporation finance and investments.*

(*a*) Forms of corporation securities; bankruptcies, reorganizations; receiverships; methods of corporate accounting.

(*b*) Organization and methods of the stock market, and its relation to corporate practice. Brief study of foreign investment markets.

(*c*) History and general principles of investments; classification of investment securities; detailed study of corporation reports from the standpoint of the investor; analysis of the investments of typical institutions, such as savings banks, insurance companies, and educational institutions.

COMMERCE AND INDUSTRY.

FIRST YEAR.

A. *National industrial efficiency.*

This course considers social conditions in their relations to industrial efficiency. Starting from the fundamental point of view, that the quality of labor is the chief element in industrial efficiency, the course undertakes a concrete study of national characteristics influencing labor conditions; religion; social customs; education; home surroundings; amusements and sports; sumptuary laws; civic administration; factory conditions; institutions for savings and insurance; benevolent agencies; organizations for relief.

B. *Economic geography.*

This course aims to bring out the general principles of the relation between man's environment and his industrial life, and then to apply these principles by taking up a study of the various countries as producers and sellers of goods and as markets. While all important regions are considered in an elementary way, a more detailed study is given to the older industrial countries of central and western Europe. Among the facts considered are the following: Physical conditions, geology, soils, rivers, climate; the nature and distribution of extractive and of manufacturing industries; imports and exports; industrial aptitudes; business methods; and national peculiarities that determine the particular classes of goods demanded. Lectures and assigned readings.

C. *Resources and industries of the United States.*

(*a*) A detailed study of the fundamental conditions of the industrial development of the United States, such as geographical, geological, and climatic factors; the extent and distribution of resources; industrial traits; labor conditions; forms of industrial organizations.

(*b*) A general survey of the development and present conditions of the more important extractive industries—agriculture, horticulture, forest industries, fishery industry, and mining.

(*c*) A minute investigation of the development and present condition of typical manufacturing industries, each being considered as to the securing of raw materials, technical processes and costs of manufacture, form of organization, methods of management, the times, places, and methods of the sale of finished products, and as to its general conditions and prospects.

Emphasis is given throughout this course to facts of practical value, and practical use is made of the material in the Commercial Museum.

D. *Commercial history and policy.*

Historical study of the tariff policy of the United States with comparative study of the policy of related countries; commercial treaties, including the policy of reciprocity; navigation laws, bounties, subsidies, preferential tariffs, and the problem of our merchant marine; the commercial relation of the United States to its recently acquired possessions. Text-book, assigned readings, and reports.

BANKING.

FIRST YEAR.

A. *Money and banking.*

A discussion of the most important features of the institutions of money, banking, and credit, with special reference to their functions in the economic life of to-day. The history of money and banking in the United States. Descriptions of the monetary and banking systems of important foreign countries. Discussion of practical problems, such as changes in the value of money and their effects on prices and incomes, bimetallism, inconvertible paper currency, the relation of the subtreasury system to the supply of money, proposed modifications in the national banking laws. Lectures on monetary and banking history.

B. *Banking problems.*

A discussion of some of the most important banking problems: The functions of commercial banks, trust companies, and saving banks; the relation between banks, the Independent Treasury, and the money market; bank examination and supervision; banks and financial panics; currency reform; the functions of clearing houses; the payment of interest on deposits; the competition of trust companies with banks; postal saving banks, and so on.

SECOND YEAR.

C. *Practical banking.*

(*a*) Examination of the mechanism and methods of different banking institutions with reference to organization, administration, investments, loans and discounts, reserves, deposits, circulation, clearing systems, correspondents, etc. Attention is given to the duties of the various bank officials and the relations of the different departments in typical banks. The main features of the present federal and state regulation of banks are studied, and proposed modifications are discussed. Comparisons are made with foreign banking methods in cases where such comparisons are instructive.

(*b*) Detailed study of the New York money market, supplemented by a general survey of the money market in London, Paris, and Berlin. Current fluctuations in money rates are recorded and analyzed. The relation of the money market to investment and speculation is emphasized.

D. *Foreign exchange.*

An advanced course, of use to men planning to enter banking or foreign trade. The course includes the study of the causes of fluctuations in exchange rates, gold shipments, international investments as affecting the settlement of balances, the monetary systems of foreign countries, and the actual methods of buying and selling foreign exchange.

TRANSPORTATION.

FIRST YEAR.

A. *Transportation.*

Steam railways. (*a*) The railway problem of the United States, including theories of rates, combination and pooling, consolidation, community of ownership, and government ownership or control, involving a careful consideration of the work of the Interstate Commerce Commission and of state commissions. (*b*) A comparative study of the railway systems of other countries, especially England, Germany, France, Canada, and the Australian Commonwealth, with a consideration of the economic significance of the world's great railway systems.

Transportation and communication other than by steam railways. (*a*) Lake, river, and canal transportation in the United States and other countries. (*b*) Ocean transportation with special reference to its relation to the transportation systems of various countries. (*c*) Interurban railways and their growing competitive power, telegraphs, telephones, and cables. Lectures, text-book, and assigned readings and reports.

B. *Interstate commerce act.*

A critical study of the act to regulate commerce, with only slight attention to its history and with particular reference to its present form as amended. The course will treat of the administration of the act by the Interstate Commerce Commission, of its judical interpretation by the courts, and of the development of its statistical and accounting features.

SECOND YEAR.

C. *Railroad service.*

(*a*) Organization. The organization of a railroad, including its charter rights, powers and duties of stockholders; internal organization for business purposes, with the various plans on different systems; officers and employees and their duties; relations of employees to their employment, including examination for employment, rules of discipline, relief departments, and pensions.

(*b*) Operation. Movement of trains, cars and power, problems of loading, car accounting and interchange, including the discussion of mileage *vs.* per diem payment, duties of employees engaged in operation.

(*c*) Traffic. Rules and regulations governing freight traffic, discussion of passenger, mail, and express service, methods of traffic development; methods of rate-making and various kinds of rates; bills of lading and other forms used in traffic handling; fast-freight lines, traffic associations, pools, and other forms of railroad cooperation.

(*d*) Mechanics. Study of the elements of railroad construction and maintenance and their costs. Details of locomotives and cars, their use, construction, and repair. Modern mechanical and safety devices, including brakes, couplers, signaling systems, and the like. Purchasing department, with consideration of properties of materials and railroad supplies. This section of the work will be conducted in part under course G (2d part) in the Thayer School of Civil Engineering, under the title, "Economics of location, construction, and maintenance of railways."

(*e*) Finance and statistics. (1) Accounting and auditing. Organization of this department, with a study of its duties and the methods employed. (2) Statistics,

Careful study of the statistical results of railroad operation and management, including the significance of the various statistical units and averages used. Reports made by railroads to the Interstate and state commissions. (3) Finance. Interpretation of railroad reports, including income accounts and balance sheets and determination of the different policies pursued as to maintenance and betterments. The more general discussion of capitalization, reorganization, and the like will be found under Corporate Organization B.

(f) Legal. The rights of railroads under common and statute law, their obligations to employees and shippers, taxation, relation to interstate and state commissions.

XIV. SUMMARY.

In a legislative inquiry several financiers in turn when called upon to define their object in building railroads enlarged in various ways upon the general, social, and economic betterment of the communities to be served. Finally it came to the turn of a very famous and practical promoter. The question was asked, "What do you build railroads for?" He answered sharply, "To sell bonds." The immediate purpose in all these enterprises is properly to make money. Because of their public character, there is much loose talk about the opportunities and responsibilities of railroads. The railroads which may be built to sell bonds, when built, are run primarily to make money. The final bar before which all questions of policy must be settled is the income account. To lose sight of this principle is to confuse the issue and pervert the real service of the railroad to the community. In order to continue to make money and to make more money, the constant problem of the manager is efficiency in every part of his machinery. But the bane of American railroad management has been and still is shortsightedness. It has not enlarged its comprehension with the growth of its machine, so as to include an understanding of the remote and indirect causes and effects with which it is called upon to deal. Among these remote effects are the factors that will make or mar the income account five years hence, ten years hence, twenty-five years hence, which are ignored in meeting some local exigency that may be but a transient phase. It is natural that the management should first see and be most impressed by those results which are immediate, tangible, and easily located—such as the wear of a rail, the life of a tie, or a locomotive fire box. Partly because they are not trained to understand, and partly because the phenomena do not easily reduce to a science, the play of those indirect causes and effects which must be referred to sociological principles to be understood, is left out of their calculation, or at best very crudely dealt with. These sociological principles are involved in the principles of organization—tenure, promotion, discipline, publicity, relation to the public.

In the course of railroad development, there was a first era, which was the era of railroad building. Any railroad was better than a wagon road. There was next an era of coordination of the railroad service and finance to the commercial and financial conditions as a whole with which the railroads were called upon to deal. This was the time of the traffic organization and railroad consolidation.

Next came the era of internal adjustment on the physical and mechanical side—perfection of the machinery, cutting down grades, strengthening bridges, increasing the train unit. And now has come the era of sociological adjustment. The human part of the machine is quite as vital as the steel and wooden part in producing efficiency, and so in increasing the income.

EVOLVING STANDARDS OF EFFICIENCY.

The state in its larger functions of supervising the productive forces identifies the losses and wastes of accident and personal injury against the production to which they were incidental. This it does by the employers' liability law. In the same way, on a lesser scale, the railroad runs over its property and makes inventory of all its parts and methods, its scrap piles and expenditures, to identify them against the particular part of the income account to the production of which they were incidental. By steadily holding its eye upon the income account and inventorying, reinventorying, and reinventorying again the phenomena and current phases of railroad operations, it successively eliminates the waste, corrects the awkward effort, and produces the greater and greater efficiency of the machine. This is a process of constant selection.

The piecework engineer has perfected the system of registry that aims to automatically and continuously enhance this process of selection. His "flat" piecework unit he "weights" with a first factor of quality and he has the "premium piecework" system. His studies in joint efficiency will lead him in time to weight it with other factors of quality that relate the work to the reserve of ability of the worker in those phases which arise from the social and continuing character of the product. This reserve of ability is both technical and general. If definitely acquired instead of being picked up by chance, the process, for the great body of average men, will be more quick and certain. Any definite plan for acquiring it, whether by apprenticeship or school, is education.

EDUCATION AND EFFICIENCY ON THE HARRIMAN LINES.

The high-water mark so far indicated in railroad operations was the paper read before the New York Railroad Club May 21, 1909, by Mr. Julius Kruttschnitt, director of maintenance and operation of the so-called "Harriman lines."

The heavy responsibilities of the manager of 17,000 miles of line are not academic nor fanciful, but very real and overwhelming:

Upon assuming the presidency of practically all the corporations comprising the Union Pacific and Southern Pacific systems, E. H. Harriman was confronted with the problem of designing an organization that would economically and efficiently supervise their operations.

The speaker proceeded, by a sequence that was unstudied, to discuss standards, organization into autonomous groups, competition within the limits of the organization resulting in constant evolution of standards, statistics, which were the terms of statement, publicity, inspection, and, capping the whole, *education*.

As illustrated on the Harriman lines, the most practical and efficient railroad manager to-day is now squarely "up against" the problem which he is attacking in one form or another, of education, of himself, his staff, the individuals in the rank and file, and the rank and file as a whole. This is the last and highest and most comprehensive stage of the function of administration. When rightly fulfilled it implies all the previous stages. It implies, for instance, an eager, resourceful, self-respecting individualism throughout the working force, coordinated with a keen appreciation of the social character of the work, which expresses itself in a loyalty not to a person or a local group, but to the income account of the railroad—nor yet to one income account, but to the aggregate of the income accounts of several years. These income accounts, showing steady, healthy growth over several years, become at the same time the terms of largest service to the community, the stockholder, and the individual employee.

SYSTEMATIC EDUCATION—SPECIAL PHASES AND SUGGESTIONS.

In attacking this now very definite problem of education, the manager has ready to hand certain very efficient tools:

1. A semimilitary organization designed to effect the will of the administrative head with least indirection and uncertainty.
2. A place in the service for every kind and grade of capacity, and large resources out of which to reward it.
3. Machinery automatically to test out and select capacity to its place of fitness and to apportion to efficiency its reward.
4. A plant of offices, shops, laboratories, and staff experts, where theory and practice meet.
5. A system of bulletins, instructions, regulations, inspection, and discipline to hold the body of learners to sharp attention.
6. An enormous potential of social motive and esprit de corps.
7. Well-tested methods of adapting instruction to various grades of intelligence and kinds of work—the catechetical, visual, oral, example, routine drill, lecture, literature.

8. Auxiliary agencies of vocational schools, correspondence schools, and cooperative technical and administrative schools.

The material on which the manager draws to recruit the service comes from the common school, the high school, or the college and technical school. These three schools represent three distinct age periods at a very formative time of life. The distinction, however, between the high-school graduate and the common-school graduate does not seem to be sharply defined. This is due apparently to the fact that so far there is very little cooperation between the high school and the railroad. To the original differences of relative maturity is added the difference of systematic mental application, and very frequently, though not necessarily so, is implied the difference of home environment and inherited talent.

Within the two extremes is a wide range of different degrees of capacity. A large part of the manager's function is the ordering of his forces into groups calling for these different grades of ability, to which are given different ranges of discretion. There are higher and lower orders of skill, or, in other words, wider and narrower ranges of difficulty with which the skill is competent to deal. The lower order of skill by long drill has become largely automatic action within fixed and narrow limits. Its power of adjustment is small. The skill of the more highly organized worker has wider ranges of adjustment; its experience is worked out in terms that are larger and which more closely apprehend the underlying principles. The apprenticeships, which are designed to work the material up the most expeditiously to the largest efficiency, should make note of these differences. The different mental grasp affects the entire prospect. The fundamental requirement that a thoroughly democratic spirit shall pervade the organization has usually been taken to mean that every man must be put in the same mixing pot, where each individual in time finds a place of fitness by natural evolution. There must, in such a system, be much lost motion, and besides it implies a system of sharply competitive measure and selection which in reality is not found. The requirement of a thoroughly democratic spirit throughout the organization would be safeguarded as well by a system of frank classification of apprenticeships and careers, provided there were arranged a system of free movement among the grades under proper competitive conditions—certainly in this way we should expect to produce the greatest efficiency. The fault is that there is too little movement among the grades except by the arbitrary measure of seniority, which very frequently has only an indefinite relation to real fitness. It results in benumbing the service when an ultimately more democratic method would stimulate. Having erred in not frankly distinguishing at the outset in the selection of their raw material, railroads continue to err more or less through the whole

process of training and advancing men throughout their careers. Promotion and the sequence of apprenticeship which it implies, in the final analysis, is a process of "fitting" in a most peculiar and especial way, and misfits of men or methods should not be permitted to invalidate the results sought. Systematic education serves the manager as a valuable adjunct because it involves a selective process that assists in designating men to their uses.

The manager has large undeveloped possibilities in systematically recruiting his men. For the greater part, who come from the common school direct, there could be carefully devised oversight for a few months. The boys could be registered in a general office with a definite plan of classifying them, discarding the worthless after a fixed probation, and sifting the others to the department for which they may show fitness. So much for the man's career and for the railroad is involved in the first stages.

In the case of the public high-school graduate, the railroad can begin to pick the recruits in the school itself by having one general railroad subject introduced in local high schools and arranging for prize papers on railroad subjects by high-school scholars. In some such way an entirely informal relation could be established with possibilities for the making of good railroad men.

The college man can be met with some provision that takes note of his greater maturity and his presumed larger mental efficiency. There can be some supervision that could test out this and the other general qualifications which it implies during a probationary period, for no permanent discriminations should be permitted on the basis of arbitrary credits.

The greatest school of railroading must always be the railroad itself. The school is only introductory and auxiliary to the service. But it is an auxiliary which can change the whole character of that service. The best results of apprenticeship are only secured when, parallel with it, provision is made for getting the significance of the facts of experience and classifying them into definite generalizations for ready use at some subsequent time. The school and its methods of instruction—lectures, demonstration, reading, laboratory, research, observation tours, seminars, and prepared papers—provide this. Such facilities give perspective to the detail of routine work. For such schools the railroad manager has experts on whom he can draw; he has easily at hand places of assembly and classes assembled and attention enforced. The expense of the whole undertaking for a series of years would be overshadowed by the cost of a single ordinary railroad accident. A half a mile more run by his locomotives to a ton of coal, would pay the bill.

A note of warning may at this time seem to be premature, but certain tendencies are already foreshadowed which should not go unchecked. When the railroad manager comes fully to realize how his new-found tool of education enables him to shape almost absolutely to his purposes the working body, there may arise the danger that railroad specialization in education be carried too far. It can easily be reduced to mere drill for the acquisition of a nimbleness in mind and fingers along certain fixed lines of routine, special to the particular place where and time when the instruction is given. To train an apprentice how to wiggle his great toe is not properly education. If the railroads, when they come very generally to instruct their employees, turn their back upon the professional teacher, severely divorcing their work in subject-matter and in method from and at the same time substituting it for the work of the regular established educational agencies of the grammar school and high school grades, the result can only be what the psychologist calls "arrested development" for the learner. Instruction in any industry, in order to justify itself from a business standpoint, obviously must be sharply utilitarian, and therefore unless such instruction is committed to wise hands the work is exposed to this danger. In this connection we quote from the report of the special committee on industrial education of the American Federation of Labor, headed by John Mitchell, at its Toronto meeting, November, 1909:

> Organized labor's position regarding the injustices of narrow and prescribed training in selected trades, by both private and public instruction, and the flooding of the labor market with half-trained mechanics for the purposes of exploitation, is perfectly tenable, and the well-founded belief in the viciousness of such practices and consequent condemnation, is well-nigh unassailable. * * *
>
> There is a strong reaction coming in general methods of education, and that growing feeling, which is gaining rapidly in strength, that the human element must be recognized, and can not be so disregarded as to make the future workers mere automatic machines.

To avoid this tendency to narrowness the committee recommended a general course preliminary to special instruction in a particular vocation, to include English, mathematics, physics, chemistry, elementary mechanics, and drawing.

> The shop instruction for particular trades, and for each trade represented, should include the drawing, mathematics, mechanics, physical and biological science applicable to the trade, the history of that trade, and a sound system of economics, including and emphasizing the philosophy of collective bargaining. This will serve to prepare the pupil for more advanced subjects, and in addition to disclose his capacity for a specific vocation.
>
> In order to keep such schools in close touch with the trades, there should be local advisory boards, including representatives of the industries, employers, and organized labor.

Railroads, as a whole, through a representative body such as the American Railway Association, should in a comprehensive way take

up the matter of the education of railroad employees. As they now have committees devoted to standards of construction, maintenance, and operating practice, they should also have a standing committee of a character to command confidence, who should sedulously foster a closer relation between the railroad and educational agencies. This could be done by roughly grouping railroad service into classes according to the requirements of service, indicating the efficiency required in a broad way, and studying the curricula and course of experience leading up to such efficiency. Such a body should officially gather all railroad literature and accumulate the nucleus of a railroad museum. In various ways the teaching force of educational agencies, training toward railroad employ, could be drawn into study and discussion of the practical everyday problems of railroad work. The large public policies involved in railroad operation are to-day left to the doctrinaire or accidental publicist, when they should be a subject of study and effective presentation by the highest grade of trained experts which the associate railroads could draw into their service. On the other hand, such a standing committee could stimulate and guide the practice of railroads in their methods of handling and instructing apprentices. Between the instruction and practice in the service on the one side, and the instruction outside the service on the other side, they could foster a closer relation, making them mutually supplementary. In developing approved plans for recruiting the service they would necessarily indicate the lines of a more direct access than now exists from the various schools to apprenticeships in the service, and suggest the best methods by which such apprenticeships could be gradually merged into the full status of regular employ at the point of special fitness.

CONCLUSIONS.

In conclusion: (1) Railroad financial managements should incorporate an educational scheme as a definite part of their policy, on the ground of business prudence. Such policies should be inaugurated for periods of not less than five years, preferably ten, otherwise the money appropriated will be largely wasted.

(2) Railroads should extend the principles of definite apprenticeship to every department of the service, and should provide for two or more grades of apprentices in order to take account of differences in capacity and work done elsewhere, either in properly accredited schools or by experience, and leading to different grades of service. Between these grades should be free movement, so that no individual should be arbitrarily designated to any class from which by his own effort he can not advance (or by his own default automatically drop out). To assure this, the tenure in any apprenticeship status should be periodically tested.

(3) There should be formal provision for movement among departments under proper conditions, and the comity of railroads should be so far extended as to formally provide for some interchange of officials under special restrictions.

(4) In executing the policy of education announced by the directors, there should be a superintendent of education reporting directly to a higher official, such superintendent to be thoroughly informed of the educational policy of the railroad and the broad considerations on which it rests. His department should systematically recruit the employees throughout the service and certify, on request, to their records and general efficiency in the early stages of promotion.

(5) Efficiency should be recognized by an efficiency wage, stated distinctly apart from the seniority wage.

(6) Employees should be encouraged to take outside courses of instruction or experience without forfeiting their tenure, and, so far as possible, the educational department should systematically turn to account every outside educational agency by suggesting courses, uniting in cooperative courses, and recognizing the work done in those courses, to the end that theory and practice be joined.

(7) The educational opportunities of the service should be utilized to the utmost by encouragement of perfect freedom of study and criticism and interchange of ideas concerning accidents, bad work, and all the details of practice. Annual or semiannual meetings of employees by classes of work and the preparation and circularization of papers and discussions should be a feature.

The time will come when railroad employ for *every* man in the service will not mean drudgery, nor sinecure, nor accidental opportunity, but an enlightened, stimulating, highly efficient service of highest earning power, least uncertainty from accidental causes, largest freedom for individual initiative, entire self-respect, and thoroughly democratic spirit.

APPENDIX A.

I.—STATISTICS OF RAILWAY APPRENTICESHIP.

The following table (pp. 140–149) gives in systematic form the particulars of the apprenticeship systems of different railroads. The information presented was compiled from the answers to a questionnaire sent out by the Bureau of Education, which is here reproduced.

DEPARTMENT OF THE INTERIOR,

BUREAU OF EDUCATION,

WASHINGTON.

RAILROAD APPRENTICESHIP.

TO THE GENERAL MANAGER: I inclose herewith schedules of questions on the subject of railroad apprenticeship. An inquiry into this subject has been intrusted to Mr. J. Shirley Eaton, of New York.

It will greatly facilitate this inquiry if you will kindly have returns made at an early date on these blanks by the proper officers of each of the following departments: Traffic, accounting, maintenance of equipment, maintenance of way, and of conducting transportation. Kindly request that all blanks be returned to this office, whether the department addressed has or does not have an apprenticeship system, making in each case the appropriate indorsement.

Trusting that we may have your valued cooperation in this matter, I am,

Very respectfully,

ELMER ELLSWORTH BROWN,
Commissioner of Education.

---

1. Name of road.....
2. Name of department.....
3. Approximate estimate of number of employees among whom apprenticeship is in force in the department.....
4. Does your department educate its own men, or depend on outside supply?.....
5. What educational qualifications, if any, do you have for an apprenticeship?.....
6. Does your apprenticeship require any coincident instruction in night school?.....
7. If your apprenticeship requires coincident instruction in night school, does the railroad support the school, or does it only designate the school?.....
8. If you require attendance at a special night school, how long is the school?.....
9. Do you have one general supervision of apprentices for the entire road, having charge of their selection, instruction, and distribution among the regular employees?.....
10. Is your policy as to apprentices left to the discretion and individual convenience of the division officers or made to accord with a general plan?.....
11. How many years are there in your course of apprenticeship?.....
12. Is the "time" basis rigidly enforced in your apprenticeship, or does the "merit" basis prevail? (By the latter is meant a system that allows credit for special work, outside study, or unusual aptitude, and so far shortens the course to the apprentices).....
13. Is there any implied contract of employment at the expiration of the apprenticeship?.....
14. Upon the completion of an apprenticeship does the road give certificates, or does it recognize similar credentials from other roads?.....
15. Do you have more than one grade of apprenticeship, beginning with different stages of fitness and looking to different grades of employment? And if more than one, how many?.....
16. Do your helpers and handy men come from boys in your employ or from those who enter irregularly and after they are grown?.....

(Signature of official reporting.)

(Post-office address.)

The representative character of the table is somewhat impaired by the fact that not every railroad has reported in reply to the questionnaire of the Bureau of Education. Some of the most important roads, as, for instance, the Great Northern, the Pennsylvania, the Louisville and Nashville, are omitted or inadequately represented, while many very small lines have been at much pains to give replies in full. Again, the significance of the table is somewhat further qualified by the fact that the answers do not always sharply apply to the questions given. This is especially true in stating the kind of instruction given and the general supervision in force.

Definite apprenticeship, as will be noticed, is confined almost exclusively to the mechanical department. In one or two cases where it has extended to the transportation department it has been made to include brakemen. The systems in force in these other departments are very fairly described by the freight traffic manager of the Chicago and Northwestern Railway, who says:

"We do not have apprenticeships as outlined in the questionnaire, but we have a system of civil service in our freight traffic department, and when a vacancy occurs we usually promote the next clerk in line for promotion, employing an office boy to fill the vacancy made by the promotion of the last employee. This is continued as far as practicable. When a clerk is needed requiring a specific knowledge and there does not happen to be one in the department capable of filling the position we occasionally have to draw from some other department of our road or from some other road, but this occurs rarely. Invariably all vacancies that occur are filled by the employment of an office boy as outlined above, and when that office boy is engaged we require that he shall have a high-school education. If he has not previously taken up the study of shorthand and typewriting, we generally recommend that he do so evenings, but we do not demand that he do so; it is entirely optional with him, but this suggestion is made that he may be promoted more rapidly."

A very considerable number of the roads have two grades of apprenticeship in the mechanical department. The majority of the roads do not yet definitely provide instruction as a part of the apprenticeship course. Of those that do, several find it the best policy, in order to make such work worth while, to include it in the company's time under company's instructors. Such courses are usually two hours a day, twice a week. The backbone of the work there is mechanical drawing.

Contract relations, either during the period of apprenticeship or guaranteeing employment at the end of the apprenticeship, are almost altogether informal.

The problem of supplying the helpers and handy men is variously dealt with. Throughout the table there is made apparent a general absence of that close relation between the public-school system—especially the high school—and the shop which has been found practicable in Germany.

Apprenticeship systems of different

Road, miles operated, and department.	Does your department educate its own men?	Educational qualifications for apprenticeship.	Does the apprenticeship require coincident instruction?	Does the railroad support the school giving coincident instruction?	Does the railroad only designate the school giving coincident instruction?
1	2	3	4	5	6
Ann Arbor (300):					
Mechanical	Yes	Common school	No		
Atchison, Topeka and Santa Fe (lines east of Albuquerque) (7,020):					
Mechanical—apprentice	Partly	Common school; five grades minimum.	Day schools on company time.	Yes	
Telegraph	Yes	Common school; good character.	No		
Atlanta, Birmingham and Atlantic (478):					
Mechanical	Partly	Common school	No [a]	No	
Maintenance of way	do	do	No		
Traffic	Higher positions.	do	No		
Atlantic Coast Line (4,368):					
Mechanical	Partly	do	No		
Maintenance of way	Yes	do	No		
Baltimore and Ohio (3,021):					
Mechanical	Yes	Common school for first-class apprentice.	Yes		Yes
		High school, second class.	Yes		Yes
		College or technological, third class.	No		
Baltimore and Ohio Southwestern (986):					
Mechanical	Yes	Common school; eighth grade.	No		
Bangor and Aroostook (513):					
Mechanical	Yes	Common school	Yes	Yes	
Bessemer and Lake Erie (201):					
Traffic	Yes	Grammar school	No		
Boston and Maine (2,298):					
Mechanical	Yes	do	No		
Buffalo, Rochester and Pittsburgh (366):					
Mechanical	Yes	Common school	No [a]		
Accounting and treasury	Yes	High school, preferred.	No		
Central of Georgia (1,913):					
Mechanical	Yes	Common school	No		
Central of New Jersey (648):					
Mechanical	Yes	"Three R's"	Encourages same.	One day school; company time.	
Central Vermont (536):					
Mechanical and car	Chiefly	Common school	Yes	Yes	
Chesapeake and Ohio (1,832):					
Mechanical	Partly	"Three R's"	No		
Chicago and Alton (T., St. L., & W. R. R's) (1,431):					
Traffic	Yes	Grammar school	Encourages same.	No	No
Chicago, Burlington and Quincy (8,660):					
Mechanical	Yes	"Three R's"	No		

[a] Company provides course in mechanical drawing.

railroads and departments.

Length of school course which gives coincident instruction.	Does the railroad have one general supervision of apprentices?	Is the policy as to apprentices made to accord with a general plan?	Years in the apprenticeship course?	Does the time or the merit basis prevail?	Is there any implied contract of employment at the expiration of the apprenticeship?	Upon the completion of apprenticeship does the railroad give certificates?	Does the railroad recognize certificates of apprenticeship from other roads?	How many grades of apprenticeship does the railroad have?	Do helpers and handy men come from boys in the employ of railroad?
7	8	9	10	11	12	13	14	15	16
.....	Yes.....	Yes...	4	Time....	No....	No....	No....	1	No.
Throughout apprenticeship.	Yes; responsible head.	Yes...	4	...do.....	Yes...	Yes...	Yes...	2	No.
.....	Yes.....	Yes...	2	Merit....	Yes...	Yes...	.....	1	
.....	Yes.....	Yes...	4	Time....	No....	No....	No....	1	No.
.....	No.....	No....	Varies.....	Merit....	No....	No....	No....	1	No.
.....	No.....	No....	Varies.....	...do.....	No....	No....	No....	1	Chiefly.
.....	No.....	No....	4	Time....	No....	No....	No....	1	Yes.
.....	No.....	No....	Varies.....	Merit....	No....	No....	No....	1	No.
First two years of apprenticeship.	No.....	Yes...	4	Time....	No....	Yes...	.....	3	Yes.
.....do.....	.....	.....	3	.....	.....	.....	.....	.....	
.....	.....	.....	2	.....	.....	.....	.....	.....	
.....	No.....	No....	4	Time....	No....	Yes...	.....	3	Partly.
Throughout apprenticeship.	No.....	Yes...	3	...do.....	No....	No....	No....	1	No.
.....	No.....	No....	Varies.....	Merit....	No....	Yes...	.....	1	Partly.
.....	No.....	Yes...	4	Time....	Yes...	Yes...	No....	1	Do.
.....	No.....	Yes...	.....	...do.....	No....	Yes...	.....	1	No.
.....	Yes.....	.....	Varies.....	Merit....	Yes...	No....	No....	1	No.
.....	No.....	Yes...	4	Time....	No....	Yes...	Yes...	1	No.
Throughout apprenticeship.	No.....	.....	4	...do.....	No....	Yes...	Yes...	1	No.
.....do.....	Yes.....	Yes...	4	...do.....	No....	Yes...	Yes...	1	Yes.
.....	No.....	.....	4	...do.....	No....	Yes...	.....	2	Yes.
.....	No.....	No....	Varies.....	Merit....	No....	No....	No....	1	Partly.
.....	No.....	Yes...	Regular 4; special 1, 3 years, 4 months	Time....	No....	Yes...	Yes...	2	Yes.

Apprenticeship systems of different

Road, miles operated, and department.	Does your department educate its own men?	Educational qualifications for apprenticeship.	Does the apprenticeship require coincident instruction?	Does the railroad support the school giving coincident instruction?	Does the railroad only designate the school giving coincident instruction?
1	2	3	4	5	6
Chicago and Eastern Illinois (958): Mechanical	Chiefly	Rudimentary	No		
Chicago Great Western (1,474): Mechanical	do	Common school; eighth grade.	No	Day classes; company time.	
Chicago, Indianapolis and Louisville (600): Mechanical	Yes	Common school	No		
Chicago, Milwaukee and St. Paul (7,410): Mechanical	Yes	Common school; eighth grade, 75 per cent.	Encourages same.	No	No
Chicago and Northwestern (7,623): Mechanical	Yes	Common school; eighth grade for regular apprentices. Technical education for special apprentices.	Encourages same, drafting required.	No	No
Chicago, Rock Island and Pacific (7,938): Mechanical	Yes		No		
Cincinnati, Hamilton and Dayton (1,038): Mechanical	Yes	None	No		
Delaware and Hudson (846): Mechanical	Yes	Common school	Day school (shop).	Yes	No
Telegraph	Yes	do	No		
Delaware, Lackawanna and Western (957): Mechanical	Yes	do	No		
Denver and Rio Grande (2,552): Mechanical	Yes	Common school, regular apprentice; college, special apprentice.	Yes	Yes	
Detroit, Toledo and Ironton (438): Mechanical	Yes	Common school	No		
Duluth, South Shore and Atlantic (581): Mechanical	Yes	do	No		
Elgin, Joliet and Eastern (280): Mechanical	Yes	Common school; eighth grade.	Encourages same.	Yes, in part.	
El Paso and Southwestern (345): Mechanical	Chiefly	Common school	No		
Erie (2,166): Mechanical (locomotive)	Chiefly	"Three R's"	Day school, company time.	Yes	
Gulf, Colorado and Santa Fe (1,491): Mechanical	Chiefly	Common school	No		

railroads and departments—Continued.

Length of school course which gives coincident instruction.	Does the railroad have one general supervision of apprentices?	Is the policy as to apprentices made to accord with a general plan?	Years in the apprenticeship course?	Does the time or the merit basis prevail?	Is there any implied contract of employment at the expiration of the apprenticeship?	Upon the completion of apprenticeship does the railroad give certificate?	Does the railroad recognize certificates of apprenticeship from other roads?	How many grades of apprenticeship does the railroad have?	Do helpers and handy men come from boys in the employ of railroad?
7	8	9	10	11	12	13	14	15	16
.....	No.....	Yes...	4	Time....	No....	Yes...	Yes...	1	Partly.
Throughout apprenticeship.	Yes.....	Yes...	4	...do.....	No....	Yes...	Yes...	1	Do.
.....	Yes.....	No....	4	...do.....	No....	No....	No....	1	No.
.....	No.....	Yes...	4	...do.....	No....	Yes...	Yes...	1	Yes.
.....	No a.....	Yes...	Regular 4, special 3.	...do.....	No....	Yes...	.....	2	Yes.
.....	No.....	Yes...	4	...do.....	Yes...	Yes...	.....	1	No.
.....	No.....	Yes...	4	...do.....	No....	Yes...	Yes...	1	No.
Throughout apprenticeship.	Yes.....	Yes...	4	...do.....	No....	Yes...	Yes...	1	No.
.....	Yes.....	No....	6 months.	Merit....	No....	Yes...	Yes...	1	Yes.
.....	No.....	Yes...	4	Time....	No....	No....	Yes...	1	No.
Six months.....	No.....	Yes...	Regular, 4; special, 2.	...do.....	No....	Yes...	Yes...	2	No.
.....	Yes.....	Yes...	4	...do.....	No....	No....	No....	1	No.
.....	Yes.....	Yes...	3	...do.....	No....	No....	No....	3	No.
.....	Yes.....	Yes...	4	...do.....	Yes...	Yes...	Yes...	1	Yes.
.....	No.....	No....	4	...do.....	No....	Yes...	Yes...	1	
Throughout apprenticeship.	Yes.....	Yes...	4	Merit...	No....	Yes...	Yes...	2	Yes.
.....	Yes.....	Yes...	4	Time....	No....	Yes; generally.	Yes...	1	Yes.

a Chicago and Northwestern Railway: At our Chicago shops we have two instructors who do nothing else except go around among the young men and see that they understand what they are doing, and also help them to grasp ideas more quickly than if left to the foreman, who would only come around semi-occasionally. These two instructors go from one apprentice to another all the time, helping them, and in this way, not only the young men, but the company gets the benefit of the improvement obtained in this way.

Apprenticeship systems of different

Road, miles operated, and department.	Does your department educate its own men?	Educational qualifications for apprenticeship.	Does the apprenticeship require coincident instruction?	Does the railroad support the school giving coincident instruction?	Does the railroad only designate the school giving coincident instruction?
1	2	3	4	5	6
Hocking Valley (347):					
Mechanical	Chiefly	Common school, first-class apprentices; college or technical school, second-class apprentices.	Yes	No	
Illinois Central (4,378):					
Mechanical	Yes	"Three R's," regular apprentices; technical school, special apprentices.	No		
Kansas City Southern (827):					
Mechanical		Common school	No		
Lake Shore and Michigan Southern (1,520):					
Mechanical	Yes	do	Encourages same for graduates.	Yes, in part.	
Lehigh Valley (1,440):					
Mechanical	Yes	"Three R's," regular apprentice; college or technical school, special apprentice.	Yes	No	No
Long Island (392):					
Mechanical	No	Rudimentary	No		
Maine Central (931):					
Mechanical	Yes	Common school	No		
Traffic, freight, and passenger	Chiefly	High school	No		
Accounting	Chiefly	do	No		
Michigan Central (1,745):					
Mechanical	Yes	Common school	No; drawing course.		
Minneapolis and St. Louis (798):					
Mechanical	Yes	do	No		
Minneapolis, St. Paul and Sault Ste. Marie (2,263):					
Mechanical	Chiefly	do	No		
Traffic	Yes	do	No		
Missouri, Kansas and Texas (3,073):					
Mechanical	Chiefly	Common school, eighth grade.	Yes; correspondence course.	Yes; partly.	
Missouri Pacific (6,472):					
Mechanical	Yes	"Three R's"	No		
Maintenance of way	Chiefly	Degree of civil engineer.	No		
Mobile and Ohio (926):					
Mechanical	Yes	None	No		
Maintenance of way	Yes	Practical special knowledge.	No		

railroads and departments—Continued.

Length of school course which gives coincident instruction.	Does the railroad have one general supervision of apprentices?	Is the policy as to apprentices made to accord with a general plan?	Years in the apprenticeship course?	Does the time or the merit basis prevail?	Is there any implied contract of employment at the expiration of the apprenticeship?	Upon the completion of apprenticeship does the railroad give certificates?	Does the railroad recognize certificates of apprenticeship from other roads?	How many grades of apprenticeship does the railroad have?	Do helpers and handy men come from boys in the employ of railroad?
7	8	9	10	11	12	13	14	15	16
Throughout apprenticeship.	No.....	.....	Regular, 4; special, 2.	Time...	No....	No....	Yes...	2	
.....	No.....	No....	...do.....	...do....	No....	Yes...	.....	2	No.
.....	No.....	No....	4	...do....	No....	Yes...	Yes...	1	Yes.
Optional.....	Yes.....	Yes...	3–4	Time, modified by previous experience.	No....	Yes...	Yes...	1	No.
Throughout apprenticeship.	No.....	No....	4	Merit...	No....	Yes...	Yes...	2	No.
.....	No.....	No....	4	Time....	No....	Yes...	.....	1	Yes.
.....	No.....	No....	3–4	Merit...	No....	No....	No....	1	No.
.....	No.....	No....	3	...do....	No....	No....	No....	1	Yes.
.....	No.....	No....	3	...do....	No....	No....	No....	1	Yes.
.....	Yes.....	Yes...	3–4	Time....	No....	Yes...	.....	1	No.
.....	No.....	No....	4	...do....	No....	No....	Yes...	1	No.
.....	Yes.....	Yes...	4	...do....	No....	Yes...	Yes...	1	No.
.....	No.....	.....	.....	.....	.....	.....	.....	.....	.....
Throughout apprenticeship.	No.....	No....	4	Merit...	Yes...	Yes...	Yes...	2	Yes.
.....	No.....	.....	4	Time....	Yes...	Yes...	Yes...	1	Yes.
.....	Yes.....	Yes...	Varies.....	Merit...	No....	No....	No....	1	Chiefly.
.....	No.....	No....	4	Time....	No....	No....	No....	1	Yes.
.....	No.....	No....	Varies.....	Merit...	No....	No....	No....	1	Chiefly.

Apprenticeship systems of different

Road, miles operated, and department.	Does your department educate its own men?	Educational qualifications for apprenticeship.	Does the apprenticeship require coincident instruction?	Does the railroad support the school giving coincident instruction?	Does the railroad only designate the school giving coincident instruction?
1	2	3	4	5	6
New York Central and Hudson River (3,782):					
Mechanical (locomotive)	Yes	Common school	Encourages same for graduates.	Yes; in part.	
Mechanical (car)	Yes	do	do	do	
Maintenance of way	Yes	Varies [a]	([b])	No	No
Telegraph	Chiefly	Common school	No		
New York, New Haven and Hartford (2,060):					
Mechanical	Partly	Common school for regular apprentice; high school (technical preferred) for special apprentice.	No		
Northern Pacific (5,448):					
Mechanical	Largely	Common school, eighth grade minimum.	No		
Oregon Railroad and Navigation Co. (1,288):					
Mechanical	Partly	do	No		
Oregon Short Line (1,462):					
Mechanical	Chiefly	Common school for regular apprentice; technical school for special apprentice.	Yes; one lecture course.	Employs lecturer.	
Operating (telegraph operators, brakemen).	Yes [c]	Common school, for brakemen, sound physique.	No		
Pennsylvania Railroad Co. (3,858):					
Mechanical	Partly	None for regular apprentice; college for special apprentice.	No		
Pere Marquette (2,362):					
Mechanical	Yes	Common school, eighth grade.	Yes	Yes	

[a] New York Central and Hudson River Railroad.—What educational qualifications, if any, do you have for an apprenticeship? *Ans.*—There are several branches of the department. For the positions of rodman, transitman, levelman, draftsman, and other subordinate positions in connection with the engineering work; an effort is being made to obtain young men who have received technical training in leading colleges, in order that they may be equipped for promotion through the various departments of the service to official positions in engineering work, such as assistant engineers, division engineers, bridge engineers, principal assistant engineers, etc. In the practical branch of the service, such as section foremen, rail foremen, ballast foremen, carpenter and bridge work, apprentices are employed who must be able to read and write and keep their records of time and material, with the expectation that they may be promoted to positions as foremen, general foremen, supervisors, etc., in charge of the practical execution of work. These apprentices enter the service in some minor position and receive training in practical experience.

railroads and departments—Continued.

Length of school course which gives coincident instruction.	Does the railroad have one general supervision of apprentices?	Is the policy as to apprentices made to accord with a general plan?	Years in the apprenticeship course?	Does the time or the merit basis prevail?	Is there any implied contract of employment at the expiration of the apprenticeship?	Upon the completion of apprenticeship does the railroad give certificates?	Does the railroad recognize certificates of apprenticeship from other roads?	How many grades of apprenticeship does the railroad have?	Do helpers and handy men come from boys in the employ of railroad?
7	8	9	10	11	12	13	14	15	16
Optional	Yes	Yes	3-4	Time, modified by previous experience.	No	No	No	1	No.
do	Yes	Yes	3-4	do	No	Yes	Yes	1	No.
	No	Yes	Varies	Merit	Yes	No	No	3	Yes.
	No	No	do	do	No	No		1	Partly.
	No	Yes	4	Time	No	Yes		2	No.
	No	No	3-4	do	No	Yes	Yes	1	No.
	No	No	4	do	Yes	No	No	1	No.
	No	Yes	4	do	No	Yes	Yes	2	No.
	No	Yes	Varies	Merit	Yes	Yes		1	Partly.
	No	No	4	Time	No	Yes	Yes	2	Partly.
Throughout apprenticeship.	No	Yes	4	Time, modified by qualifications.	No	No	No	1	Chiefly.

[b] Yes; in engineering department when education has been limited to common school.

[c] Oregon Short Line Railroad.—Student brakemen are selected from men who are physically and mentally qualified, and are educated by being sent out on road and observing work of regular crews. There is a telegraph school located at Pocatello, Idaho, and one at Salt Lake City, Utah, where students get rudiments. After graduation they are given positions as student operators when there are openings, and when they become proficient as railroad operators are made such at regular operator's salary.

Apprenticeship systems of different

Road, miles operated, and department.	Does your department educate its own men?	Educational qualifications for apprenticeship.	Does the apprenticeship require coincident instruction?	Does the railroad support the school giving coincident instruction?	Does the railroad only designate the school giving coincident instruction?
1	2	3	4	5	6
Philadelphia and Reading (1,000):					
Mechanical	Partly	Common school	Encourages same.	No	
Pittsburgh and Lake Erie (191):					
Mechanical	Yes	"Three R's"	No		
Rutland (468):					
Mechanical	Chiefly	Common school	No		
San Antonio and Aransas Pass (723):					
Mechanical	No	Common school, eighth grade.	No		
Transportation (brakemen, switchmen, and clerks).	Partly	"Three R's"	No		
San Pedro, Los Angeles and Salt Lake (1,036):					
Mechanical	Yes	Common school	No		
Seaboard Air Line (2,617):					
Mechanical	Yes	do	Encourages same.		
St. Louis and San Francisco (5,064):					
Mechanical	Yes	Common school, eighth grade.	Yes	Yes; one.	Yes; Y. M. C. A. schools.
Telegraph	Partly	Common school, rudiments of telegraphy.	No		
St. Louis Southwestern (1,454):					
Mechanical	Partly	Common school	No		
Southern (7,546):					
Mechanical		do	No		
Maintenance of way	Yes	do	No		
Union Pacific (5,663):					
Mechanical	Yes	do	Yes	Yes; one.	
Telegraph	Partly	do	No		
Wabash (2,514):					
Mechanical	No	"Three R's"	No		
Western Maryland (543):					
Mechanical	Partly	do	No		
Wheeling and Lake Erie (496):					
Mechanical	Partly	Common school	None available.		
Wisconsin Central (1,023):					
Mechanical	50 per cent.	Common school, eighth grade.	No		

railroads and departments—Continued.

Length of school course which gives coincident instruction.	Does the railroad have one general supervision of apprentices?	Is the policy as to apprentices made to accord with a general plan?	Years in the apprenticeship course?	Does the time or the merit basis prevail?	Is there any implied contract of employment at the expiration of the apprenticeship?	Upon the completion of apprenticeship does the railroad give certificates?	Does the railroad recognize certificates of apprenticeship from other roads?	How many grades of apprenticeship does the railroad have?	Do helpers and handy men come from boys in the employ of railroad?
7	8	9	10	11	12	13	14	15	16
.....	No.....	Yes...	4	Time....	No....	Yes...	.....	1	Yes.
.....	Yes.....	Yes...	4	...do....	No....	Yes...	Yes...	1	No.
.....	No.....	Yes...	4	Time; merit recognized by increased pay.	No....	No....	No....	1	No.
.....	No.....	No....	4	Time....	No....	Yes...	Yes...	1	No.
.....	No.....	Yes...	.....	.....	No....	No....	No....	.....	Chiefly.
.....	No.....	No....	4	Merit...	No....	Yes...	Yes...	1	No.
.....	No.....	Yes...	4	Time....	No....	Yes...	.....	1	Partly.
Six months for first three years.	Yes[a].....	Yes...	4	...do....	No....	Yes...	Yes...	1	No.
.....	Yes.....	Yes...	1 (variable).	Merit...	No....	No....	Yes...	1	No.
.....	No.....	Yes...	4	Time....	No....	Yes...	Yes...	1	Yes.
.....	Yes.....	Yes...	4	...do....	No....	Yes...	Yes...	1	Partly.
.....	No.....	No....	Varies.....	Merit...	No....	No....	No....	1	Partly.
Throughout apprenticeship.	No.....	Yes...	4	Time....	No....	Yes...	Yes...	1	No.
.....	Yes.....	Yes...	Varies.....	Proficiency basis.	Yes...	No....	No....	1	Partly.
.....	No.....	Yes...	4	Time....	No....	Yes...	Yes...	1	No.
.....	No.....	No....	4	Merit...	No....	Yes...	Yes...	1	No.
.....	No.....	No....	3-4	Time....	No....	Yes...	Yes...	1	No.
.....	No.....	No....	4	...do....	No....	No....	No....	1	Partly.

[a] St. Louis and San Francisco Railroad.—The last six months of the apprenticeship are served in the main shop.

II.—APPRENTICESHIP REGULATIONS OF TWO SELECTED RAILROADS.

A closer view of the systems in force is offered by the printed regulations of one or two of the roads, which are here appended. The Atchison, Topeka and Santa Fe regulations are those of a road where special attention is given to apprentices, while those of the Seaboard Air Line are a fair sample of those of a road which has not given special attention to this matter.

THE ATCHISON, TOPEKA AND SANTA FE RAILWAY SYSTEM.

Regulations of the Apprentice Department.

1. Boys under the age of 16 years or over 22 years are not to be accepted for employment as apprentices, except in California, where they should not be employed under 18 years of age. Special apprentices may be employed without regard to the maximum age limit.

2. Whenever practicable, preference shall be given to sons of employees.

3. Applicants must pass a medical examination, Form 1693 (excepting paragraphs 12, 13, and 14), before the local company's physician, proving him to be sound physically and mentally; the expense of this examination to be borne by the applicant, and must be made by company's physician.

4. Applicants who are addicted to the habit of smoking cigarettes will not be employed, and apprentices who acquire the habit of smoking cigarettes will be discharged.

5. Applicant should have a good common-school education sufficient to enable him to read and write the English language, to make out his application on a blank provided for the purpose, and to enable him to make the ordinary computations in arithmetic, including addition, subtraction, multiplication, and division of numbers of four figures.

6. The chief officer at each shop will make the selection of apprentices from the applications, in conjunction with a representative of the apprentice department, who shall sign the application paper.

7. Three hundred full shop days worked during regular shop working hours shall constitute one year on agreement.

8. Apprentices will work ten hours per day each working day excepting Saturday, regardless of the number of hours worked by other shop employees. On Saturdays, during the months of June, July, and August, apprentices will work five hours (if master mechanic or shop superintendent so decides) and be credited with five hours on pay roll and ten hours on agreement. On Saturdays of all other months they will work nine hours and be credited with ten hours, both on pay roll and agreement.

9. When shops are closed for the entire day apprentices will not work nor will they be paid or allowed time on agreement for such days.

10. Apprentices who do not work the full shop working hours will be credited on their agreement and on pay roll with the actual number of hours worked, in tenths of days.

11. Apprentices used on regular night work will be credited on their agreement and pay roll with the actual number of hours worked.

12. No allowance shall be made on apprenticeship time for overtime (that is, time worked outside of regular shop hours), but pay will be allowed on all overtime worked in accordance with current rules governing overtime.

13. On account of apprentices working at night not being in a position to receive the benefits of our apprentice shop and school instruction, they must not be assigned to regular night work, excepting in cases of emergency, and then never for a longer period than six consecutive nights.

14. Time lost by apprentices will not generally be allowed, but in cases of personal injury for which the apprentice is in no way responsible and in which the circumstances are such as to warrant the allowance of the time lost, such cases must be submitted by the respective master mechanics or shop superintendent with their recommendation to the supervisor of apprentices for his approval.

15. Apprentices may be transferred from one shop to another upon approval of the master mechanic or shop superintendent of the shop in which he is working and the shop to which he desires to be transferred and the supervisor of apprentices. The time served by the apprentice at the first shop shall be credited to him in the time to be served in the shop to which he has been transferred.

16. Credit in rate and time not to exceed two years may be given for previous work of the same class as that for which the apprenticeship course is served. Such credit to be given only after written approval of the supervisor of apprentices.

17. Schools of instruction will be established at all the principal shops, where shop arithmetic, rudiments of mechanics, mechanical and free-hand drawing, and such other branches deemed advisable by the management will be taught. Apprentices are required to attend these schools of instruction regularly, and must diligently apply themselves to all branches taught, the object being to broaden and train their minds and enable them to successfully master their trade. They will be paid their regular rate while attending school.

18. Apprentices not showing an adaptability for the work will be dismissed during the first six months or they may be transferred to other employment. Foremen and instructors should pay particular attention and report instances of this kind.

19. Apprentices will be subject to the same regulations in regard to discipline as any other employees of the company.

20. At the expiration of the apprenticeship those who have satisfactorily completed their terms shall receive certificates signed by the proper officials of the company.

21. Apprentices who have completed their course as indicated by the award of the above-mentioned certificate may continue in the employ of the company at such rates as are paid to journeymen in the shops in which they may work, or at a rate their ability and service may justify.

22. All matters pertaining to apprentices should be addressed to supervisor of apprentices at Topeka.

——— ———,

Supervisor of Apprentices.

Motive Power Department.

Our advance system of apprentice instruction comprises two phases, that in the school room and that in the shop itself.

The apprentice is required to work in the shop, along with the other mechanics, for a period of four years, during which time he is given every opportunity of becoming a first-class mechanic in his particular trade, whether machinist, boiler maker, blacksmith, cabinetmaker, tinner, or painter.

His rates of pay during the four years of apprenticeship are as follows:

First six months	$0.95	Fifth six months	$1.45
Second six months	1.10	Sixth six months	1.60
Third six months	1.20	Seventh six months	1.75
Fourth six months	1.35	Eighth six months	1.95

At La Junta and points west thereof and on the Coast and Gulf lines, owing to the extra cost of living, the rates are 25 cents a day higher than those shown above.

As an inducement for the apprentice to complete his course, he is given at the expiration of his apprenticeship a certain amount for each day actually worked while serving his time, the total amount being about $135. He is also given a handsome certificate or diploma, signed by the master mechanic or shop superintendent, the supervisor of apprentices, and superintendent motive power. Apprentices who have satisfactorily completed their course, as indicated by the award of the above-mentioned certificate, may continue in the employ of the company at such rates as are paid to journeymen in the shops in which they may work, or at a rate their ability and service may justify.

In the larger shops there is an apprentice instructor for each department (or one for about every 25 boys), who devotes his entire time to the apprentices, watching over them, and showing them the various steps necessary in the manufacture and repair of engines and cars. He not only gives the apprentice the necessary instructions for each particular job, but transfers him, as rapidly as his ability and progress justify, from one machine or kind of work to another, thus giving him the variety of work needed to make him master of his trade.

The apprentice is required to attend the apprentice school two hours a day two days a week and is paid for this time the same as though he were at work in the shop. Here he is taught mechanical and free-hand drawing, shop arithmetic, and the elements of mechanics—the object being to enable him to make a working sketch, to read intelligently the blueprints from which he must work in the shop, and to work out the various problems which will arise from day to day in carrying out his regular duties as a mechanic. In brief, he is taught to use his brains as well as his hands.

The local management of each shop makes the selection of apprentices—at some points the number on the waiting list being so great that the applicant must wait at least six months before his turn comes to be employed as an apprentice. The applicant must be at least 16 and not over 22 years of age, he should possess at least a common-school education, and should be sound physically as well as mentally. The application should be in the form of a letter, addressed to the shop superintendent or master mechanic of the shop in which the applicant desires to learn his trade, and should state the trade he desires to learn, his age, height, weight, education, previous mechanical experience, if any, and any other information that may be of interest. Below is a list of the points where apprentice schools have been organized, also the name of the shop official to whom the application should be made:

Topeka, Kans., superintendent of shops; Cleburne, Tex., mechanical superintendent; San Bernardino, Cal., Albuquerque, N. Mex., Shopton, Iowa, La Junta, Colo., Raton, N. Mex., Newton, Kans., Arkansas City, Kans., master mechanic.

——— ———,

Supervisor of Apprentices.

SEABOARD AIR LINE RAILWAY.

Rates, Rules, and Regulations for Shop Apprentices.

First.—Only those who are over 16 years of age, or less than 20 years of age, will be employed as apprentices; each person so employed will be required to furnish the company with a minor's release (on form provided for the purpose), properly executed by his parent or guardian.

Second.—The term of apprenticeship will be four years (not calendar years) of three thousand hours each, of days consisting of not less than ten hours each, excepting Saturday half-day holiday, which time shall be included in apprenticeship time when made.

Third.—The first year of the apprenticeship time will be considered as probationary; and apprentices failing to show an aptitude for their trade or due diligence at their work will be dropped at the end of that period, or earlier.

Fourth.—Apprentices are subject to the shop rules and the general rules and regulations of the company, and are liable to discipline or discharge for violation of these rules.

If an apprentice considers himself unfairly treated, he has the right of appeal in person or by representative as per general shop rules and regulations.

Fifth.—The wages (per hour) paid apprentices are as follows:

	For first, second, third, and Birmingham divisions.	For fourth, fifth, and sixth divisions.
	Cents per hour.	*Cents per hour.*
First year	7	7½
Second year	9	10
Third year	12	12½
Fourth year	15	15

Sixth.—Apprentices who are working with mechanics on piecework jobs will be paid their regular hourly rates. Apprentices working overtime will be paid at overtime rates for time worked, but only the actual hours worked will be counted in the apprenticeship period.

Seventh.—Apprentices will be given the best opportunity to learn their trades and become good mechanics.

Eighth.—Apprentices will be expected to improve themselves by reading and drawing and by attending night schools when practicable.

——— ———,
Superintendent Motive Power.

APPENDIX B.

EDUCATIONAL AND WELFARE WORK ON EUROPEAN RAILROADS.

It may be of interest to refer very briefly to the practice of two European countries in work bearing on the welfare and efficiency of railroad servants. The references are made with no attempt to cover the subject in any systematic way.

Germany.

In a recent article—the second of a series—published in the Archiv für Eisenbahnwesen for 1907, which appears under the auspices of the Prussian ministry of public works, a report is made on the welfare work of Prussian-Hessian railway districts for the year 1905.

The organization of the work is, roughly, as follows:

1. Betterment of living conditions:
   Tabulation of 8,694 two, three, four, and five room dwellings, by railroad inspection districts.
2. Care of employees during periods of rest and intervals between work and service:
   (*a*) Rooms, with cook stoves, where men can spend the night.
   (*b*) Equipment of cars with gas or coal stoves, so that men can prepare warm food for themselves, etc.

3. Care of health:
   (a) Medical inspection and service free.
   (b) Special attention to tuberculosis with attempt to improve living conditions.
   (c) Care of the sick, and instruction of small children in little towns where the population is chiefly railroad people.
   (d) Better establishment of homes.
   (e) Keeping of sickness, invalidism, and death records.
4. Rewards:
   (a) For long service; 12,120 workmen were rewarded in 1905 as against 2,370 in 1903 (442,490 marks, 1905; 88,190 marks, 1903). In 1904 the conditions of availability for reward were made easier. For instance, illness was no longer counted as an interruption to service. Long-term service rewards varied from twenty to fifty years.
   (b) Recreation days, short vacations, and other freedom from service under certain conditions and in certain grades.
   (c) Provision against exposure—warm clothing, waterproof clothing, etc.
   (d) Free transportation.
   (e) Garden land for city employees to raise vegetables, etc.
   (f) Coal supplied at cost.
   (g) Efforts in the direction of houses of convalescence and recovery. Four or five "homes" for locomotive men, etc.
5. Measures to protect workmen against accidents and to care for victims of same.
6. Labor committees, with power to receive communications from laborers as to grievances, etc., to discuss these questions, and to settle disputes between laborers when requested by both parties so to do.
7. Railway clubs. October, 1904, 467 local clubs with 247,600 members; 1905, 637 clubs, membership 350,800. These organizations interest themselves, among other things, in—
   (a) The care of sick.
   (b) Free classes for teaching families how to keep house. The clubs nurture the consciousness among the employees of unity of interest as members of a great, governmental administrative body.
8. Homes for the unmarried daughters of railroad men (40,000 marks donated by the Kaiser).

France.

The Engineer, London, January 24, 1902, prints an article on "Technical education of railway apprentices in France." Quotations from this article with an abstract of some portions of it are as follows:

"Chief among the social and benevolent institutions organized by various French main-line railway companies is that which concerns the education of their apprentices."

Conditions vary on different lines. The Chemin de Fer de l'Est maintains courses both rigorous and thorough in method, "though a little exclusive." Apprentices have been in service here since 1852, but the schools proper date from 1884. They are for mechanics only, engineers being excluded. The type of French locomotive driver is, however, high in intelligence and professional knowledge.

In the maintenance of these schools two motives actuate the management—the philanthropic and the practical. The rate of pay for apprentices from the commencement of service is 1 franc per day at Paris (La Villette), and 50 centimes in the company's other shops at Epernay, Mahon, and Romilly. The pay may be augmented every five months at the rate of 25 centimes for the best workers. Apprentices get medical and dispensary aid and free passes.

In order to assist the older employees with families to maintain, the sons of such employees have the preference. The lads must be from 13 to 16 years of age, of French

birth, and physically sound. They must be able to read, write, and figure. Because of the good training and good moral environment ("close and solicitous superintendence") which is given the apprentice, the applications are very numerous. Hence the father's record, as well as the applicant's ability, is considered.

The number of apprentices engaged under these conditions is as follows:

Number of apprentices:

Epernay (locomotive shop)	100
Rolling stock department—	
Romilly, Mahon, La Villette	75
Various small repair shops	40

Since 1884 there have been sent out 1,430 trained men from these shops.

Character of work.—The term of apprenticeship is from three to four years, upon the completion of which the apprentices serve two years as mechanics' helpers, either in groups or along with the men and in the daily round of shop work. They then become day workmen paid by the day. There is no contract; either party is free at any time to withdraw, but the discharges are very few and the effort is to keep the boys with the road after the apprenticeship is completed. Where military service interrupts their railroad work, the boys return, after serving their terms, to the grade previously occupied, provided their record has been good.

The course of training is divided into two distinct heads—manual in the shops and theoretical in the class rooms. The first is intrusted to gang foremen and leading hands of well-known proficiency and trustworthy character, who stand and work with the apprentices and exercise the greatest possible care in their mechanical education, which is of course progressive and graduated according to the natural capacities and physical strength of the learners. Then, in addition to the branch which the apprentice has chosen for his specialty, he is also given facilities for gaining an elementary knowledge of such collateral shop trades as most generally come into touch with his own work.

The theoretical teaching intended * * * to continue the primary knowledge acquired at school by the apprentice usually comprises reading, writing, orthography, history and geography, arithmetic and geometry, mechanical drawing, elements of physics and chemistry, technology, mechanics, laying out of machine work, etc.

These classes are in charge of the head staff of the shops—generally the foremen and draftsmen, who very frequently were former pupils of the École des Arts et Métiers, and whose experience, specialization, and capacity are a guarantee for the ultimate success of the apprentices. Two hours daily are taken up by theoretical and manual instruction in the manner which we describe subsequently. In order to encourage and stimulate the efforts of learners attending these classes, prizes of well-chosen books are distributed at the end of each annual term to the most meritorious of those who have been classed first at the shops and in the classes. The term commences October 1 and ends some time in August.

LOCOMOTIVE SECTION.

At the locomotive works at Epernay the educational course consists of reading, writing, French, arithmetic, geometry, algebra, physics, chemistry, cosmography, mechanics, technology, and a brief outline of political economy. The studies extend over a period of four years, the time passed in each of the classes being two hours per day. Each class consists of 25 pupils, forming one division, and all the usual accessories and materials are furnished by the company.

FOURTH (OR LOWEST) CLASS.

Geometry, Book I; arithmetic; introductory French; grammar; introductory orthography; history of France, from the Gauls to 1789.

Geography, etc.: Geography of France, commerce, industries, government administration.
Sketching: Line drawing.

THIRD CLASS.

Geometry: Book II and problems; Book III.
Arithmetic.
French grammar, including original reports on shop work.
Geography, physical and political, of European countries.
History of France, 1789 to present time.
Sketching: Line drawing.

SECOND CLASS.

Plane geometry, Book III, Book IV, and problems on Books III and IV; geometry in space.
Arithmetic: Revision of third class, etc.
French: Literature, home exercises, reports, etc.
Orthography.
Cosmography: A few lessons.
Technology: No. 1, pattern making; No. 2, foundry practice; No. 3, forges.
Sketching: Line drawing.
Shop lectures.

FIRST CLASS.

Mechanics: Statics; kinematics: Study of divers motions; strength of materials; dynamics.
Technology: General considerations on the different parts of a locomotive boiler, etc.
Algebra: Introductory ideas.
Physics: Introductory ideas; hydrostatics; atmospheric pressure; heat; electricity, static and dynamic, introductory ideas.
Chemistry: Introductory ideas; metalloids; metals; metallurgy; organic chemistry, introductory ideas.
Political economy: A few ideas.
Sketching: Line drawing.
Shop lectures.

PROGRAMME OF ROLLING-STOCK WORKSHOPS.

Second (lower) division.—Grammar, arithmetic, geometry, freehand drawing, technology.

First (upper) division.—Grammar (revision, exercises, narratives, etc.), arithmetic, geometry, freehand drawing, line drawing, technology and mechanics.

COURSES OF PRACTICAL WORK IN CARRIAGE SHOPS.

Fitters, two years; turners, three years; tinsmiths, three years; carriage builders, three years; pattern makers, three years; painters, three years; trimmers, three years.

The aim of the courses is to make a body of workmen from whom excellent foremen may be drafted.

Results.—These are, as a whole, very satisfactory. Of course the value of the artisan will depend much upon his individual propensities and abilities; but the least that can be said is that lads so trained become good workmen, trustworthy, and of excellent conduct. Some at this day are the leading shop hands and foremen, and a few have even advanced to superior positions.

A school similar to that conducted by the Chemin de Fer de l'Est was organized by the Chemin de Fer du Nord in 1883.

INDEX.

O