LOGGING TRANSPORTATION

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TIMBER TRANSPORTATION

The transportation of timber from the time it is felled and bucked in the woods until it is delivered to the mill-pond for sawing, is one of the most imortant problems of the timber industry. Because of the complex problems confronting the person performing the transportation, care must be exercised in the movement of the logs to keep the cost within a range of financial figures that will permit some profit or net returns on the time and money expended. Otherwise, the cost of delivering the logs might be too high to permit net returns for the complete operation, and would thus compel the operator to close his camp. While competition plays an important part in regulating the price paid for logs in the mill pond, the actual cost of delivery is the cost that determines the price paid over a long period of time. If there should be an operator able to deliver logs to a mill at a fixed price, and another man, through different management and methods of logging were able to deliver the logs to the same mill for a lower figure, the latter would be employed.

The business world does not cater to old ideas for their own sake. If a new method of action can be found to do the same, or better work for a lower cost, the old habit will be dropped for the new. One must be alert to the opportunities awaiting him. He must advance with the times, or die with the old and antiquated methods of doing things. Progress is being made, and the logging industry is only one of the many professions that change to meet the times and customs.

Northwestern logging outfits working in the fir, spruce, and hemlock forests of Washington and Oregon are cutting timber that pays a heavy tax to the county, state, or association to which they may belong. This heavy tax makes it necessary for the operator to harvest his timber crop as quickly as possible. They therefore deliver their logs to the mill as soon as possible because of the size of money invested and the interest on their capital. In order to transport their logs to the mill many methods and ideas on transportation play their part. Through carefully checking figures on cost, depreciation, and overhead, many logging concers have introduced new methods of logging, and accepted plans necessitating an entire change of camp and working plans. Through the introduction of modern machinery and equipment, new plans of delivery have been drawn to cope with the increasing demands for more and more logs. In meeting these demands logging transportation plays its part.

The transportation of logs falls under two sub-divisions. The divisions are major and minor transportation. Minor transportation deals with the transportation of logs from where they are cut in the woods to a landing near a railroad, truck road, flume, river, or point where the logs can be conducted on to the mill. On some of the smaller outfits scattered throughout the woods, minor transportation may be the only method used or necessary to deliver logs to the mill. As the cutting line of the timber recedes, however, the major transportation problem enters the field, and in most cases, is the most expensive of the two classes of timber transportation.

Major transportation deals with the moving of the logs from the landing by the railroad, truck road, flume, or river, to the mill. While the methods of delivering the logs to the mill are many, and differ with localities, more than one, and often many different methods of transportation man be employed within one area, by the same logging operator. The transportation will depend upon a number of factors that must be considered when plans are drawn for the delivery of logs.

The first, and major consideration given the transportation of logs is the cost. It is economically necessary to hold the cost within a monetary limit that will permit the continuation of the practice, and it is financially necessary to keep the costs as low as possible. If the cost of the logs delivered to the mill will be greater than the market price of the logs, logging can not take place with any hope of a monetary reward to the hauler or person responsible for the delivery. Because of the necessary cost consideration, many isolated spots of timber are not logged, or are logged at a loss to an often surprised and disappointed operator. It is hardly wise to attempt an adventure for gain when one can not avoid a loss, yet because of the failure to consider costs before starting to log an area, there are many small operators in the logging woods who are forced out of business yearly. And all because they did not consider their cost factors. Too much emphasis can not be placed upon the importance of considering this important cost factor in logging transportation.

Considerations involved in the plans to transport logs are: The size of the logs, their length and weight, climatic conditions, existing media of transportation, distance of the haul, character of the timber, size of the operation, value of the timber, demands of the market, topography of the country, and the equipment available for use at the time. While there arw many minor considerations to be handled by the prospective operator, the list given above covers the general problems that must be solved for any successful project. Without proper plans and due consideration given the conditions surrounding the woods and ways, an operation is doomed before it begins its work.

The size of the logs is important because one must plah his media to conform to the weight of the logs and their size. One can not haul a big log unless there are proper means available. If on a river drive, there must be enough water in the stream to keep the logs floating, and if on a railroad, or on a truck road, there must be provisions made that will permit the handling of the largest logs to go over the route. If one is about to plan a road, flume, chute, or skid, and long logs are to be hauled, the operator must plan his project to handle them. This means that the proper work must be followed in the construction of the bed, and that curves, banks, and grade must be compensated for before any movement of the logs can take place, otherwise, one will be apt to lose his load. Large and long logs can not be flumed, chuted, or skidded if the curvature and grade are too great to hold them. On a railroad or truck road the grade and curvature is likewise considered, but is handled differently. On logs of over seventy feet in length it is deemed inadvisable to have curves greater than twenty degrees. Shorter curves may result in thrown loads, broken cars, and expensive repairs, especially when any degree of speed is maintained during the haul.

The weight of the logs play an important part in the selection of transportation media because a given plan may not be practicable. If in a position where river driving or fluming can be used, one must be certain that the logs will float. The heavy logs like the oak, hickory, butt logs of spruce, some fir, and some cedar will not float, and when an attempt is made to drive them they must be fastened to other and lighter logs that will keep them afloat. For this reason, many plans have to be changed for transporting timber, and may often result in postponment or abandonment of logging given areas.

Due to the climatic conditions prevailing in some sections of the country, logging can be carried on, when under similar conditions other than climatic, it would be impossible. The part climate plays in logging is exemplified in the Northeastern part of the United States. Snow sleds are able to operate in hauling loads during the winter months. Through the cheapness of sled transportation, work can be carried on in the winter, but not in the summer when other methods of haul would have to be used. In parts of the West where there is little rainfall, cheap roads can be be built that will safely carry logs, but if there was a heavy rainfall, better roads would have to built. This added work on the roads would add to the expense of the operation, and in some cases might not justify the logging.

Existing media of transportation plays its part in the logging operation because it may decide the profitableness of logging an area. Everyone knows that where there are goods roads ready for use, one can afford to make longer hauls, and go further from the mill for logs than if all of the road work must be done by the logger himself. Without end, many a logger goes many miles from his mill after logs. He may build several miles of roadways, but because of existing roads for him to travel a part of the distance, he may still be able to build a lot of road work, go a long distance from the mill for logs, yet make a profit. On the other hand, if the person doing the logging had to to all of the road building with his own money, the cost of road alone might be more than he would receive for all of the timber in that region. While roads are by no means the only media of transportation, they are of importance, and really active operators count on them to a large extent. If the existing media be that of a river, flume, or any other useful means of transporting logs, it should be carefully considered before making any attempt to log an area, and is given due account by the wise logger.

The character of the timber is one of the items to consider before logging an area. One would be foolish to try to deliver timber having little or no value at the mill. In the Northwest timbered area there are many types and species of trees having little or no value under the present conditions. The trees may be of inferior grade, of little use, or in little demand. Because of the law of supply and demand, it is unwise to harvest a crop of timber where there is no chance for a reward, when a reward is sought.

The size of the operation regulates the transportation insofar as there can be no attempt to log an area where there must be a heavy expenditure of money at the beginning of the logging plan, unless the consumption of the products will be great enough to pay dividends on the money invested. If there was a tract of timber that would require a hundred thousand dollars to tap with a road, and the only mill operating within the area had a ten or twenty M capacity, at a glance, one could tell that it would be foolish to attempt such a venture; yet there are people considered wise in some respects who make this kind of error in judgement. Profit is the prime objective of any business, and one must make a profit from his ventures if it is to be a success.

Demands of the market, of course, are important in the process of logging. Where there is little demand for a product, little or no attempt is made to log or supply it. This often works a hardship on the logging industry. The Northwest is a timbered area, yet there are many species of trees that have little or no value. The timbermen there are faced with the hemlock problem, and it has been an expensive sore spot with them for years. The general public is prejudiced against the use of this tree, and prefers not to use it at all. Because of this fact, where there is a particularly heavy stand of hemlock, logging of the other species is unprofitable. On the other hand, if there were a demand for hemlock lumber, or for pulp, logging could be practiced profitably. It is only within the past few years that any attempt has been made to induce the American people to use the lumber of this tree in construction and other projects. The tree's lumber has a great many uses, and for some work is a highly desirable wood. No doubt there will be more and greater demands for hemlock in the future, but at present, it is still in popular disfavor. Consequently, hemlock, except for pulp products, is logged with other species of trees, not for the value of the logs, but because of the growth connection, and the cheapness of logging after once getting an outfit rigged up to log.

The topography of the country is perhaps one of the most important problems to consider in drafting plans to operate a logging show. Because of the cost factors, and because of the different kinds of equipment needed for various conditions, special care is given almost every case where large sums of money ~~is~~ are involved in logging. Open country, with gentle grades and rolling hills will permit equipment to work that would be impossible to use in rougher country. In Eastern Oregon, or for that matter, in the country east of the Cascades, road building is very cheap. There are many operations that spend but a hundred dollars a mile for the construction of their roads. In addition to the one hundred dollars for the road is a cost of three hundred dollars for ballast. With the total price of only four hundred dollars a mile for road construction on the east side, one can easily tell why logging over a great distance is a paying proposition. Yarding in such a country can be regulated to almost any demands, while the region west of the Cascades presents a much greater problem, and requires different methods of logging. Better roads, and greater road maintenance is necessary where the road is rough and there is a heavy rainfall. No one solution for the problem applies to all of the different section of the country within the logging industry in the same manner, or to the same extent, but there are a few basic principles that not only apply to all practices, but actually regulate them. Topography is one of these factors, and it must be considered when logging takes place.

As mentioned in the first part of this report, cost is the first and most important factor to consider in figuring timber transportation. This factor controls all activities, and is the first factor to be considered in planning any logging activities. The cost of logging does not mean the cost of the labor in getting the logs to the mill, but labor costs are included in the total logging costs. When one attempts to figure costs, he must include all of them if an accurate figure is reached. This cost must include labor, materials, fuel, parts, insurance, taxes, depreciation, overhead, and upkeep. Among the costs to figure are the costs of the machinery, its depreciation, and also its repairs. Where a number of machines are used, the depreciation, upkeep, insurance, and other costs amount to a considerable figure, and a wise logger computes the costs well before making any attempt to log. Costs alone, will in turn be dependent upon a very great number of factors. These factors aid in regulating the cost of the job, and for that reason the more important items will be discussed.

The size and amount of timber regulates the amount and kind of machinery that is to be used in the transportation of the timber, and governs the cost of the machinery in that manner. For example: Suppose there was tract of timber about to be logged, and when the plans were drawn it was found that there would have to be a railroad built, and there would be donkey engines used for yarding because of the topography of the country. Here the logging costs would include the cost of the locomotives and other railroad equipment, the cost of the donkey engines, and all of the equipment on the logging show, lines, wires, blocks, all material and labor, as well as the fixed costs of the outfit. The fixed costs are those that do not change from season to season, but remain constant, like taxes, and some insurances.

If the plans for logging should find the country suitable for truck hauling and caterpillar yarding, the logging costs would be much different from the costs in the country which had to be logged with donkey engines, or if logging railroads had to be built. If the truck and caterpillar equipment were used, the costs would include the initial costs of the trucks, caterpillars, the lines, blocks, fuel, all of the tools and other equipment, all labor, insurance, taxes, and maintenance. If the equipment were not worn out on the logging operation of the tract of timber, the costs of logging the tract would include: the cost of the stumpage, total labor costs, the fuel, repairs to the machinery, insurance for the time the machinery was used, taxes for the time the logging took place, industrial insurance, and the depreciation of the machinery and equipment for the time it was used on the operation.

There are several methods of figuring the depreciation on any part of equipment, but perhaps the most common method used in the Northwest, is the straight-line method. This is a direct figuring process, and for all general methods is quite accurate, providing the equipment decreases in value at the same rate over its lifetime. Because of its simplicity in usage, the straight-line method is by far the most popular, and the results are constant. The straight-line method of computing the value of equipment is to assume the machinery depreciates at the same rate over its lifetime. By taking the original cost of the equipment, adding to that all of the repair costs, then dividing that figure by the number of years of service, one finds the yearly depreciation of the machine. The formula given above is applicable to equipment with no value at the end of its servicable life span. If, on the other hand, the equipment has some value, one takes the original cost plus the maintenance cost, minus the residual value, divided by the number of years of its serviceable period to obtain the yearly depreciation.

There are other methods of determining the depreciation of equipment as with the ratio of four, three, two, and one, on a basis of ten. For example: Assume that a piece of equipment is purchased and has a life span of five years.

For the first year forty percent of the original price would be deducted, thirty percent of the original price for the second year, and so on for the five years. At the end of that time there would be no value in the equipment, and its value would be allowed for during the five years.

The size of the timber is not the only factor that regulates or determines the kind of machinery to be used on a logging show. The value of the timber plays an important part in the selection. If the timber has an unusually high value, great care is taken to prevent unnecessary breakage or loss of sound logs. This care leads to the use of machinery and equipment having a low damaging effect on the timber, and the exclusion of equipment that would have a high breakage record. Port Orford cedar is an example of timber that is seldom logged with the North Bend, or other slack-line skidder systems. The high-lead system is used in a number of places, but the most popular method is the caterpillar ground skidding, and selective cutting. In less valuable stands of timber within the same region the slack-line and other air-line skidder systems are employed for the yarding. Of course, one can not lay down any hard and fast rules about logging of any one particular location. The topography of the country may be such that logging without the aerial skyline can not take place with any degree of success, or profit, and then that method is used. It migh be possible to log in an area where there will be a high degree of breakage, yet that method remains the best method to use in that location. While breakage decreases the loggable timber, and of course, cuts down on the profits to be made, it might still give the greatest returns for the effort.

The silvicultural considerations given the young trees and future growths also regulate the equipment to be used in logging an area. If one is interested in doing as little damage as possible to the trees left standing, and to the young trees getting a start in the forest litter, the method of logging will be much different, and brush disposal will be different from logging on an area where no consideration is the future trees. This safety precaution would continue from the time the trees were marked and felled until the timber had been logged, the brush disposed of, and the logs delivered to the mill, or to some point out of the growing area. Contract felling and bucking has proved in the past to be very destructive to the growing timber, and then too, in contract felling there is an added breakage in the felled trees themselves. This greater breakage is explained through the contractors having little interest in the manner of getting the trees down and worked up, other than making it as easy, quickly, and convenient as possible. They are primarily interested in getting the tree worked up as quickly as possible- if it means more money to them. Because of the high percentage of breakage, and lack of consideration for future growths given by contract fallers and buckers, many outfits that at one time practiced the contract system have discontinued it for a straight day-wage system. This leads to less damage to the forest, as well as cuting down on the breakage to the standing trees, and except in small logging outfits, day-wages are used.

The distance of the haul of logs from the place where they are felled in the woods to the place where minor transportation ends and major transportation begins is important. The kind and distance of the haul determines the machinery to be use on the logging show, and the machinery in turn, aids in determining the cost of the moving. The distance of the haul is given special consideration. There are limits to the distance which any type of machinery can operate with a satisfactory degree of efficiency, and then too, there are limits to which machinery can be used at all.

In the Douglas fir region where the donkey engines are used for yarding and swinging, it is the practice to use not more than one yarding donkey and two swing donkeys for any one haul. If the timber lies further from the landing than can be reached with the yarding and two swing donkey engines, a truck road is built to give closer yarding limits, or a spur railroad track is built to tap the timber. Should the timber be in extremely rough country, to the extent that much powder work would be necessary in order to build the road, the timber may not justify harvesting, and would not be cut. Here the principle of supply and demand governs and would, of course, decide the question of logging. Under some set-ups the timber may be transported a great distance and yet have a profit realized on the venture, while on the other hand, even a short distanced haul would be unprofitable. The factors controling the conditions alone govern the distance of the haul, and other depending agencies merely tie in with the factors to limit the hauling distance.

The equipment available for use must play its part in the cost of supplying logs, because the machinery, as mentioned, regulates the cost in some respects. A gasoline caterpillar costs a great deal more to operate than a Diesel caterpillar, but if the operator has a gasoline caterpillar already, it would be foolish for him to junk the gasoline caterpillar and buy a Diesel motor when he has only a little timber to log, and has much money tied up in his standing equipment. Business demands that one make the best use of what one has, and if there is machinery on hand that can be used, it is best to use it, unless it can be disposed of without realizing too great a loss on the transaction. There are a number of logging operators in the Northwest today who would gladly turn to logging with Diesel caterpillars and quit the high-lead and slackline system altogether, if they did not have such an enormous amount of money tied up in equipment having a five, ten, or even fifteen year life of service in them yet. And they can not afford to junk their equipment, because its residual value would be practically nothing.

There is one outfit having twenty-one wood and oil-burning donkey engines. The logging superintendent stated that they would gladly switch to Diesel donkey and caterpillar engines for their logging work if it were not for the fact that the new equipment cost so much money, and they would be unable to realize more than twenty cents on the dollar for their old equipment. He stated, however, that the company would never buy any more of the donkey engines burning wood or oil, and that as the present equipment wore itself out it would be replaced with the modern equipment. One can presume that there are many logging outfits in the logging business confronted with the same problem.

Brief mention has been made about the topography of the country to be logged, and its effecting the selection of the equipment and method of logging aregion. While there are regions east of the Cascade mountain range where topography takes a back seat in importance, on the west side of the said range of mountains the topography must be considered because of the cost factors involved. On the east side of the Cascades a logging truck road may be built for as little as hundred dollars a mile, and in a number of places, no grading at all. At other places rather extensive roads must be built for the traffic to reach the timber. Road work runs inot big money, and the rougher the country is, then the greater the need for good roads. This road work ranges from that done by the truck driver, as he scouts out the route he will follow, to the work done by skilled engineers and their helpers. Care must be exercised in some locations to see that the proper curves and grades are placed in order to insure the safe delivery of the loads. The same rule applies to the construction of railroads and flumes or skids. They must be properly designed and constructed or they will not carry the loads entrusted to over them, and then, they do not of course, fulfil their objective. They are built for the purpose of transporting logs, and if they do not do this safely, they are worse than useless, because all of them cost money, and it would cost more money to correct any mistakes made on the first work.

The above discussion has been a general one dealing with the minor transportation of logs from the time they are hauled from the place where they are felled in the woods to the point where the major transportation is to conduct them on to the mill pond for further work-up, and is intended to give only a rough, general idea of some of the problems, or a limited view of some of the general factors to consider before going into the logging problems dealing with the actual transportation. The minor transportation is the first transportation of the logs, ans is closely followed by the major transportation. Because of the dove-tailing of the two transportations it is sometimes hard to determine where minor transportation ends and major transportation begins. The factors that influence the selection of the method and equipment are practically the same in a number of cases in the different parts of the country. The problem of the minor transportation is to get the logs to a point or place where they can be transported to the mill. The cost is important, and is the one factor with which all others must blend with, whether in the logging business, or any business that is to survive.

The factors of both major and minor transportation, except that of existing media of transportation, have been discussed, and that discussion now follows. If there should happen to be some media of transportation, one is tempted to use it, even though other methods of transportation might prove to be much cheaper. If there is an existing method of delivering logs, it will be used, providing there is no other cheaper method on hand. On the other hand, if one had to prepare the method to use, its construction would prove to be higher than the sost of the logs when delivered over the route. This is found in a number of cases where an operation takes place near a standard railroad. There is an outfit logging in Northern California that is doing its timber cutting in the Western Yellow pine region about sixty-five miles from Oroville, California. Yet they have their mill in that town. The Union Pacific railroad line runs through the region they are logging, and the railroad hauls their logs to the mill at a given figure. (The exact figure is not known) If the logging outfit were to have a good truck road into their logging area they would be able to deliver their logs to the mill at a lower price than they have to pay the railroad. Because of the roughness of the country and the high cost of construction work in building a truck road, the company finds it cheaper to pay the railroad its price to deliver their logs to the mill. This method of haul makes logging more expensive, but it can not be corrected without proper, or different methods of carrying the logs. Often simple transportation is at hand.

If the logging takes place near a river of a size great enough to float logs, and the mill is down stream from the cuting place, the the major problem of transportation is solved. Taking out the loss through sinker logs and loss through breakage and brooming, river driving is the cheapest method of moving logs. In addition to being the cheapest method, river driving is perhaps the oldest method as well. Unfortuanately, all logging operations are not located where there is an opportunity to take advantage of river driving, and have to resort to other methods of delivering logs. This adds materially to the expense of delivery, and is made up in the higher costs of lumber delivered on the open market, and because logging conditions can not be helped.

While the preceding pages have been devoted to a light cover of some of the conditions confronting a person in the logging field, the following pages are to be devoted to actual observations made with the C. D. Johnson Lumber Corporation, Camp 12, Toledo, Oregon. An attempt will be made to cover the field of logging transportation and the problems that have been faced and solved in planing to log an area for the merchantable logs. The observations took place over a two year period, in the summers of 1936 and 1937, and are what was actually seen.

Before an area is entered for the purpose of logging, it is first cruised in order to determine the amount of material possible to log within the area. From the cruise one is able to determine how much ~~he~~ will be expended ~~spen~~ on the area, and how it will be logged ~~what he will do in logging it.~~ Before the cruise takes place, however, the area must be determined, and this calls for a survey of the region. The original surveys are made by licensed suryeyors, and the section, quarter-section, and other corners are located and marked. The cruiser then enters and cruises the timber, and is able to determine what part of the country to confine his work to, and what boundaries to run on his work. His cruise will give an accurate amount of timber within the designated area, and the logging engineer can plan his work accordingly.

When the C. D. Johnson Lumber Corporation is about to enter an area for more timber, they first send out their engineering crew, consisting of the chief-of-party, one or more compassmen, chainmen, and at least two axemen with each compassman. With the compass, the section lines and quarter-section lines are re-run and blazed. This is to re-locate the corners, most of which have long since grown over with brush, trees, and other material since the original survey was made. The timber is then cruised and plans are laid for the construction of what railroads and spur-lines will be necessary to log the area.

The engineering party will then set out to run a rough, or reconnaissance survey to obtain the picture of the topography of the country. The reconnaissance survey is followed by a preliminary survey, and topography is taken at right angles of the "P" line, as the preliminary survey line is called. The topography is taken every hundred feet, and is then plotted on a map. From this plotted map, the location of the road is made, and that survey is then run through the region. A location line is the actual location of the road, and must be so located that the proper grade and curves are put in the line to prevent the trains from throwing loads when hauled over the tracks. With the trains at Toledo, and camp, the outfit seldom has a grade over four percent, and curves greater than twenty degrees. The tendency is to have as few curves and the smallest grade, yet consistent with a good location to the greatest body of timber. Conditions are sometimes such that low grades and gentle curves are not possible to give the route desired and then of course, the greater ones must be resorted to. The limit of grade is that which the railroad can haul its load over, and the curvature that which will permit the longest logs hauled over the line to make the turn. (The longest logs hauled over the road are eighty feet, but shorter lenghts are the rule. Fifty to sixty foot logs are considered as long.)

When the location of the railroad has been established, the clearing gang of fallers and buckers start clearing all of the trees along the route. Everything is cut. The trees are felled and bucked into lengths that can be handled by the yarding donkey. In addition to cutting the material along the right-of-way, all material is felled that might fall on the road after its completion. This strip will vary in width according to the hight of timber along the location, but in most of the Douglas fir region is about four hundred feet wide.

Following the fallers and buckers in their work comes the yarding crew using a Diesel donkey engine for their work. They cold-deck all of the good logs cut along the right-of-way in large piles. The high-lead system is employed for this work because of its ease in erection, and the small crew needed to operate the rigging. Because of these factors, the high-lead system is a cheap method of yarding logs. The longest haul is seldom greater than eight hundred feet, and along the right-of-way, at irregular intervals, one will find great piles of logs that have been cold-decked, to be later loaded on railroad ~~truck~~ cars when the road is finished and logging starts.

The powder monkey and his helper follow the fallers and buckers and cold-decking crew. His duty is to blow all stumps along the line that will interfere with the grading of the road bed, or not give proper clearance to the loads. If the location runs through rocky ground, then drills are used to sink holes in the rocks. With dynamite the rocks are blown loose from their original position to permit their being handled by a gas shovel or caterpillar Diesel doing the grading. Because of its effectiveness, thirty, forty, or sixty percent dynamite is used for the rock work, and twenty percent stumping powder is used on the stumps.

Stumps require a slower acting charge of powder than rocks. An effect that will be a pushing, rather than a shattering effect found in higher explosives. Twenty percent powder has this required "push", yet is powerful enough to do the required work, and is therefore used in blasting stumps.

Either the electric cap or the cap and time fuse may be used as primers, and both forms have the merits and special uses.

In determining the amount of powder to use for blowing stumps, or dynamite to use in rock work, the powder monkey relies upon experience gained through the handling of the explosives, and then uses his own judgement. His duty is to blow all material that might be in the way that can not be handled with the caterpillar or gasoline shovel when they attempt to begin grading, and it is his policy to use lots of explosives for the job. If he thinks ten sticks will lift the stump or rock, he will probably put in from twelve to fifteen sticks of powder to be sure that the stump or rock is blown clear of its bed. An improperly blown stump or piece of rock will have to be blown again, and it is not only better to do the job well the first time, but is also cheaper in the end, and will use less explosives.

When the powder monkey has cleared an area of stumps and other materials that might give the Diesel caterpillar or shovel some trouble to get out of the way, the grading begins. If the going happens to be in rather hard soil, the shovel will scoop out most of the dirt and deposit it to one side of the roadway, or put it in such a position that the bulldozer blade of the caterpillar can carry it out of the way. On deep cuts, the shovel may have to take several layers of cuts. This is because of the fact that the bucket of the shovel can be lowered only so far. It will therefore take one cut of dirt down as far as it can reach with ease for a distance, then come back over the area and take other cuts until the line is down to grade. Over a period of earthwork, ?it has been found that the shovel moves earth at about nineteen cents a cubic yard. This figure is high when compared with other methods of moving earth when they can be used. However, one can be assured that the shovel is not permitted to do work that can be done by the Diesel Caterpillar at a lower cost per cubic yard. Most work done with a caterpillar is cheaper than the same work done by the shovel, unless the ground is hard, and then the blade of the catterpillar will not cut through the hard earth. In such a condition, the shovel will have to be used.

For loose rocks and medium-to- soft earth, the caterpillar is one of the cheapest, as well as the most popular methods found to handle the material. With a caterpillar one can move as much as five hundred cubic yards of material in eight hours, and the cost per cubic yard is very low. The caterpillar will be driven up to a lead of material, the blade lowered into position, and the power applied. The blade of the bulldozer will then roll and push the material before it, and out of the way. Fills up to twenty feet high and four hundred feet long can be made cheaper than piling can be driven and maintained over a period of fifteen or twenty years, providing there is an adequate supply of loose material for the fill capable of being moved by the caterpillar. Wet weather hinders effective use of the caterpillar, and sticky mud on adverse grades renders it practically useless, but for general uses the caterpillar has proved itself to be one of the best all-around machines ever introduced into the logging woods. Its uses are multiple. It can be used for road construction and maintenance, yarding, hauling of rigging, supplies, loading, ground logging, as a high-lead, and many other uses. Careful checking of figures has revealed that it cost about ten cents a yard to move earth on a grading job. This figure compares well with a cost of nineteen cents per yard for the gasoline shovel. On a little over two miles of railroad construction on the main-line, the seventy-five Diesel caterpillar paid for itself through the saving of money over what it would have cost to build the road with the equipment available before the company purchased the caterpillar. With such savings of money through through the use of modern machinery, the logging industry is able to continue to log, even in the face of low sales prices for their lumber during panics or depressions. It is in being awake to the money saving devices that permit one person to make money on an operation when his fellow competitors are losing money and going out of business.

Following the powder monkey and grading crew in the line of road construction, come the bridge workers and steel-laying gangs. The bridge crew puts in all necessary bridges and trestles. Their work must necessarly precede the steel-laying gang, yet remain close enough to them for the purpose of obtaining materials used on the construction. The bridge crew is generally a picked one, and the work calls for strenuous, yet skilled labor because of the necessity for close measurements that must follow throughout. A description of bridge work will be covered later.

When the steel-laying gang starts to place the steel on the ground they follow track-center stakes set by the engineering crew. This survey will give the exact location of the rails, and the rails are then spiked to ties. For this work, the rails and ties are brought out to the end of the line on flat cars, and as the neew arises, they are pulled forward and placed into position. The size of the rails is denoted in weight by the yard, and that used is sixty-five pounds per yard, made by the Colorado Steel Company. There are a number of sixty-pound rails used, but the tendency is towards the heavier type. From Camp 12 to Toledo, the line is about half seventy-pound steel, the other half being sixty-five pound. The extra weight has proved to be the best used. Its superior qualities are that it holds up better under heavy loads, and requires less maintenance than the lighter steel. However, the company can not afford to throw away the lighter rails merely because the heavier rails are better. They use the steel until it is worn out, or can be sold with a reasonable loss. To do otherwise would be costly and foolish, and neither has a place in the logging industry.

Following in the wake of the steel-laying gang comes the maintenance gang. The purpose of this gang is to place the ballast, and put the proper grade in the line. The ballast is needed to keep the rails at an even grade and to hold them there under the loads being hauled. Generally, this gang of workers is a little more experienced and higher paid crew of men than the steel-laying gang, and are picked for this purpose. The sole qualifications for a person to get on the steel-laying gang is that he have a strong back. The same qualification applies to one getting a job with the grading gang, but there is one additional requirement, and that is that the person must also use a little grey matter in his work.

In planning for the grade on a road, one must remember to keep it on an even keel, and must have all curves run without crooks or bends. On mainline railroads there is first laid about a foot thick layer of rocks and gravel. This is the sub-ballast. On top of this layer, and between the ties, is laid an eight inch layer of gravel, called the top ballast. This layer of gravel is packed tightly around the ties to prevent their moving in any direction, and by holding the ties tightly, also holds the rails. On long grades, or on steep slopes it is sometimes necessary to anchor the rails to keep them from sliding down hill and bending or twisting. The anchors are made in this manner: There will be a dead-man set in the ground, (or a stump might be used) and about the dead-man (or stump), will be placed a cable. The cable will run down to and through a hole in the rail from the under isde. The slack will be taken up in the line and the cable spliced. This makes the anchor firm, and will not let the rails slip or slide down hill. The number of anchors used will depend upon the length of the climb, the grade of the road, and the kind of load hauled over the rails, as well as the speed of the train over the line. For average work, one dead man for every six-hundred feet of road on a four percent grade is sufficient. There may be times when this given figure will not be enough, and then other times, when it will be more than enough. The best bet for preventing rails from sliding is found to be good ties, sound nailing, and lots of well-packed ballast.

When the steel has been laid for the rails, and the ballast firmly set in its position, the railroad is ready for travel, and in most cases, traffic is started over the line. Among the first things moved over the line are the donkey engines that are to be used for the yarding, swinging, and loading of the logs taken from the woods.

These donkey engines are mounted on long sleds made from choice fir logs, and are built to withstand hard usage and wear. There are two logs used for runners. They are generally about five feet in diameter, and from fifty to sixty-five feet long. The loading sleds may be fifty feet long, but the yarding and swing sleds are nearly always sixty-five feet long. The two logs are of good quality, and are fastened together with braces. The boiler and mechanism of the donkey engines are then firmly fastened to the sleds to prevent their being dislodged during movements, or operations in logging. The average life of the sleds is from four to six years, the time depending upon the use given the donkeys, and the kind of country they operate in. In a rough, rocky country where there is much moving about over the terrain, one can not expect the sleds to wear as long as those operating in a flatter, or softer bedded country, or where there are few moves to be made.

The sleds of the donkey engines are expensive, and are of such importance that they must be considered in the logging costs for any outfit where a notice is given the expense of production. In the building of a sled, there are two divisions of the expense; first, the material costs, and secondly, the labor costs. The labor costs are high because of the nature of the work requiring a high degree of skill in making the fittings. The logs must be cut down, and the holes bored to correct measurements. The fittings must be made strong and solid or the sled will not perform its expected duty. In the material of the sled's construction, only number one logs are used, and without defects. They must be straight, smooth, of slow growth, and entirely sound. The other lumber is better than number one common. The only material that may be used in more than one sled is the iron bars and rods. The iron is of common-bar material, and may be used several times in the construction of different sleds. Their use will of course, depend upon the amount of damage given them during the life of the individual sleds.

Another great cost of logging transportation that must be given special notice is the high cost of wire rope and cables. This cost is of such magnitude that under some logging operations it may amount to as much as thirty-five cents for each thousand board feet of timber logged. While this figure is high, the average cost for wire rope over a period of logging would lower that price seldom more than ten, and rarely more than fifteen cents per thousand. The cost of wire rope and cable is of major importance because there is a great deal of breakage, raveling, and repairs done on the ropes each day, and also because the rope lasts but a short time under hard strain and usage. Most of the time, and for almost all work except where sharp turns, bending, and flexibility are required of the rope, regular-lay wire is used. This rope is stronger and does not ravel as badly as long-lay wire. Long-lay rope, on the other hand, is built for the express purpose of permitting the rope to be twisted, rolled, and sharply turned. Both ropes have their uses and were built for their respective demands. While very effective results have been secured from both kinds of wire rope, the wire costs are still of major importance in logging transportation, and must be considered.

While the railroad clearing, stump-blowing, grading, and steel-laying are taking place in the transportation scheme, plans for timber work is being carried on, and the trees themselves are being worked up for their journey th the mill. Sets of fallers and buckers are busy in the woods felling and bucking all of the valuable timber. Working under the supervision of the "bull-buck", the commercially important trees, or those trees that will interfere with the logging, are felled and cut in convenient lengths for yarding, or are cut so that the most timber can be realized out of the tree. For example: If the log length that can be handled on the railroad is fifty feet, and a break comes in a tree eighty feet from the butt, two logs forth feet long will be cut, rather than one fifty, and one thirty foot log.

Other factors that determine the length of the logs will be the capacity of the donkey engine to haul the logs in to the landing from the place it is felled in the woods. On skeleton car, the logs must not exceed the length of the cars. Large logs are cut shorter than small logs for ease of handling and for the weight considerations on the railroad. The railroad is constructed so that logs up to eighty feet in length can safely be hauled, but logs of this length are the exception, rather than the rule. For general lengths, the average would be around sixty feet long. All of the trucks used are the divided type, and enable one to adjust them to any length that will best fit the load. Skeleton cars will not do this, and because of the ease of handling, as well as the initial cost, the divided trucks are preferred by this logging outfit.

Following the fallers and buckers in their work in the woods comes the scaler who scales all the merchantable timber that has been cut. This practice is performed for two reasons. First, there is an accurate check on the amount of timber cut, and secondly, the company is able able to determine the efficiency of the individual crews. The Columbia River log scale is used, and a good set of fallers can fell forty thousand board feet of timber when working under a good set of conditions. The timber must be of good size, not too scattered, be on gentle slopes, and not too much underbrush to hinder moving their tools. The tools must be kept in the best of working conditions, and sharp saws are issued every other day.

When the timber has been cut into the proper lengths, and the buckers are out of the immediate vicinity, the minor transportation begins its wheels of work, and starts to "deliver the goods". Taking the first, and simplest form of transportation used, the high-lead (and it is used whereever possible), logging starts. The donkey engine is moved into position, and the spar tree is rigged. Here, I might add, that before the clearing gang starts cutting timber for the right-of-way there are certain trees marked in strategic places along the route. These trees are to be used as spar trees for yarding, swing, or loading, and are not cut.

When the donkey engine is placed into position, and the spar tree is rigged with the blocks, lines, and guy-wires necessary to facilitate the logging and anchorage of the tree, the logging begins. On the high-lead system, only one spar tree is used. This is the most simple of all overhead rigging, and consists of a main cable, called the main-line, and a smaller cable, called the haul-back line. The system works by having a choker, a steel cable generally about thirty feet long, mounted on a swivel at the joining of the main-line and haul-back line, called the butt-rigging. The main-line is fastened at one end to a drum on the engine. From there, it passes through a block mounted near the top of the spar tree, and then runs out through the timber that is to be logged. There the main-line is joined on to the haul-back line and choker. The haul-back line goes through a block anchored to a stump, and then through another block that will put the haul-back line clear of the working area; thence, back to the donkey engine drum where it is run in or out as the occasion demands. When the haul-back line is pulled in on its drum, it pulls the main-line out in the woods. There the choker is placed about one or more logs and fastened. Then, at the proper signal from the head rigger, passed on to the donkey puncher by the whistle punk, the main-line is tightened, and the load is pulled into the landing. As the main-line is hauled in on its drum, the haul-back line is played out, and then when the load is delivered to the landing and has been unhooked, the rigging can be sent back to the woods for other materials.

The high-lead is the principal system used in the Northwest, and is of high value as a means of yarding timber in this region. Its capacity is limited only by the amount of time it takes to set the rigging about the logs, haul it in to the landing, unhook, and snake back to the woods again. The average production for this outfit is around a hundred fifty to a hundred seventy-five thousand board feet for an eight hour shift, but under ideal conditions the production may exceed that figure. On the other hand, however, there are many days when the production will not exceed fifty, or at the most, a hundred thousand board feet because of poor timber, bad weather, broken rigging, and other causes.

The cost of the high-lead system is much lower than the cost of most skidder systems of yarding logs. The crew is smaller than is necessary for, say the slack-line or the North Bend systems. The donkey engine used on the high-lead is generally a three-drum rig, but two drums may be used. The donkey engine used for the slack-line or North Bend system is a four-drum engine. Three drums are used for the power rigging and the fourth drum is used on the hay-wire. The extra drum on the donkey engine is an item of cost over and above that of the engines necessary to use on the high-lead. Therefore, the initial investment is also cheaper in buying an engine to operate a high-lead system over and above that of the other methods.

While the high-lead system is the most common system found in the Northwest, it is also found in almost every logging section of the United States, and in some foreign countries. Because of the ease with which the rigging can be set up and operated, as well as the high production of the operation with its efficiency, the high-lead will no doubt continue to hold its place in the logging world where aerial systems are used. The only factor preventing greater use of the high-lead is the limited distance of the haul. The maximum distance to which the high-lead can be used is twelve hundred feet. The average haul is about eight hundred feet. This factor in itself, is sufficient reason for limiting the high-lead as a yarding unit. For short hauls, or for cold-decking logs, the high-lead is used almost altogether.

The next method of yarding timber to be discusses that is used by the C. D. Johnson Lumber Corporation, is the North-Bend One-part main-line system. This system requires two spar trees, the head and tail spar. To the two spar trees is fixed a sky-line. This sky-line is anchored at the ground beyond the tail spar tree, passes through a jack close to the top of the tree, then continues to the head spar tree. Here it passes through another tree jack, and then goes down to the donkey engine, where it operates on a drum. A carriage with rollers operates along the sky-line, and as required, is moved back and forth along the line between the two trees. Hanging from the carriage is a drop-line. This drop-line is fixed at its carriage end, at the other end to a drum on the donkey engine, first passing through a guide-block on the spar tree. Hanging below the drop-line is a swivel block, and fastened to the block is the choker and the haul-back line. The haul-back line is run through a block at the tail-spar tree, and then goes through another block to put the line clear of the working area. From there it runs back to the donkey engine where it operates on a drum. The haul-back line pulls the carriage, choker, and main-line out to the woods. There, when slack is given the main-line, the choker is lowered to the ground. The choker is then placed about the log, and when the main-line is tightened the load is lifted at one end. As more power is applied on the main-line, the load is carried in to the landing and the choker is unhooked. The haul-back line then returns the rigging.

The North-Bend One-part main-line has proved itself to be a great help to the loggers in rough country, and it is of great importance as a yarding agent. Longer hauls are permitted with this system than with the high-lead, and rougher country can be covered more easily with this system. Because of the longer line, and the sky-line, a bigger donkey engine must be used than on the high-lead, and a larger crew is also needed. Due to the longer sky-line, more logging can be done without moving the rigging, and this condition deserves credit. The average production with the North-Bend is well over a hundred fifty thousand board feet for an eight-hour shift when work is done under normal conditions. On a poor show, the yarding average may drop below that figure, but the other set-ups will balance the production. The North-Bend system is a boon to the logging industry, and is likely to remain as one of the yarding methods as log as logging takes place in rough country with donkey engines. The maximum distance that can be covered with the North-Bend is twenty-two hundred feet, but the average distance is about fifteen hundred.

The other system used in yarding logs used by the C. D. Johnson Lumber Corporation is the slack-line. With the exception of the high-lead, this form of yarding is perhaps the most popular with timber workers in the Northwest where donkey engines are used. The slack-line is an easy, yet efficient method of delivering logs to the landing.

The slack-line, like the North-Bend, requires two spar trees to operate. The tail spar tree is out in the woods, and the head spar tree is at the landing with the donkey engine close by. A sky-line is needed in the operation, and like the North-Bend, is fastened to the ground beyond the tail spar tree. From the ground, the line passes through a jack on the tail spar tree, and runs through a carriage, then on through a jack at the head spar tree and on down to a drum on the donkey engine. Hanging from the carriage is a fixed drop-line. To the drop-line is fastened a swivel block, and on the block is fastened the main-line, haul-back line, and the choker. On this system of overhead logging, the sky-line controls the handling of the logs. To take the carriage out to the woods, the main-line is cast off, and the haul-back line is tightened. This pulls the carriage, choker, and main-line out to the timber. The slack-line, as the sky-line is referred to, is loosened until the choker can be placed about a log. When this has taken place, the slack-line is tightened until one end of the log is in the air. The slack-line drum is then locked in place. The main-line then operates, pulling the carriage and log in to the landing. When the log is in to the landing, the slack-line is loosened to permit the log to be lowered to the ground, and the choker is then cast off. The rigging is then ready to go back to the woods for other loads.

In delivering logs to the landing for loading, there may be only one donkey engine used if the haul is a short one, but if the haul is greater than can be made with one haul, or with one donkey engine; one, and often two other engines will be placed to help carry the logs to the railroad. The donkey engines taking the logs gathered from the woods is called the yarding donkey, and the engines thant carry the logs on towards the landing by the railroad is called the swing donkeys. The swing donkeys may be placed at the limit of the haul of the yarding donkey, and will be rigged up on the same spar tree. The head spar tree for the yading engine will act as the rear, or tail spar tree for the swing donkey engine. As the loads are yarded and brought up to the yarding landing, and the choker cast off the logs, other chokers from the swing donkey line will be placed about the logs, and the loads will continue their journey on down to the railroad. In case more than one engine acts as swing donkeys, the logs would be delivered to the spar tree where the chokers of that engine could get them.

Should the distance from the timber to the landing be greater than can be reached with one yarding and two swing hauls, a spur-railroad , or logging truck road will be built to get closer to the timber, or, should this method prove to be too expensive, the timber will be left standing. Attempts to go further for timber than two swing and one yarding donkey hauls has proved to be more expensive than the timber is worth, and if the spur-railroad or truck road is not built into the timber it is not cut, and no logging takes place within that area.

When the logs have been delivered to the landing by the railroad, the loading takes place. A donkey engine is used as the power unit, and a spar tree is used. It may be that the loading spar tree is also one that is rigged with equipment and used as a yarding or swing haul, but the loading equipment can also be placed on the tree and operated at the same time. In Western Oregon the MacLean boom is the most popular method used is loading, and is the method adopted by the C. D. Johnson Lumber Corporation. The MacLean loader operates by having two large poles fastened about seven feet apaert, and about forty feet long. Generally, the logs are of good quality and about thirty inches in diameter. They are fastened together with braces, and then rigged to the spar tree in such a manner that the boom will have one end butting against the tree, and will revolve back and forth around it. The boom is placed in a horizontal position about thirty feet from the ground, and held in this position by guy-wires fastened to the upper part of the tree. By means of blocks on the two outer ends of the boom, with wires through them, side movement of the boom is mantained. One of the wires will be run out to the top of a tree, through a block, and then fastened to a piece of wood. The weight of this wood will swing the boom in that direction when the opposite wire is slackened. This weight merely takes the place of an extra drum on the donkey engine. The wire on the other end of the boom will run through a block to one side of the opperation, and then will be connected to a drum on the engine for direct control of the boom by the donkey engine. From the main drum of the donkey engine there runs a line up the spar tree, through a block, and then out to the boom. Here it is divided, and large grab-hooks are placed upon the two ends of the main-line that go through the boom. These hooks pick up the load. After the load has been picked up by the hooks the boom wires are used to swing the boom around until the load is over the cars to be loaded, and then the load is lowered into place.

The MacLean loader is easily adapted to almost any kind of loading, and can be quickly rigged up. Its capacity is limited to no size of logs. It can handle the biggest logs grown, or it can pick up the smallest logs used. On some operations, over three hundred thousand board feet have been handled in an eight hour shift. At the C. D. Johnson operation, a good average would be about two hundred twenty-five thousand board feet for the shift. Under favorable conditions the capacity is greater than under adverse conditions. In addition to the natural requirements for loading, one must have a good crew, a crew who can tell where, when, and what to load, and how to place the load to keep it in place where it will not be thrown from the moving train.

When the logs have been loaded upon the cars with the MacLean loaded, they are ready for their trip to the saw mill dumping pond. In this case, the trip is a railroad haul of about sixteen miles. First the logs are placed on the bunks of the divided cars, and then the cars are rolled ahead where they will be out of the way of other cars that are being loaded. In order that the cars can be rolled ahead after being loaded, the spur line that the cars are loaded on is built on a grade, sufficiently long, and great enough to permit several cars to be loaded and then rolled out of the way by hand, without the need for having a locomotive around to do the work. When enough cars have been loaded to constitute a train load for the engine, it is brought forward and hooked to the cars. The train journey then begins. Where the grade is steep, the engine can not, of course, haul many cars to a trip. For the average load with a rod-driven engine, seven cars loaded with about ten thousand board feet to the car is a load. Ten cars make a load for a Shay engine. The logs are hauled to Toledo, where they are dumped into Yaquina Bay and sawn when desired.

Sometimes the logs hauled into the bay are longer than are required at the mill, and there is a small power saw operating in the bay to cut the logs to the desired length. Where there is a power saw with free room to operate without moving, the bucking can be done more cheaply than the work can be done by hand, and in the water, logs can be handled very easily.

As has been mentioned in preceding pages of this report, often in the timbered field there will be odd patches of timber a little too far away from the main-line of the railroad to be reached with a yarding and two swing units, and that in a case of that kind, a spur track is often built out to permit the timber to be logged. Sometimes a spur track is impracticable. If the ground is very steep, or the timber lies over a ridge, instead of building a spur line railroad to twist and wind about the hill in order to reach the timber at a reasonable grade for the trains, logging trucks may be used. More and more, in the Northwest, the tendency is towards using motor trucks for hauling, and where they can be used, are preferred. Motor truck roads can be constructed more cheaply than a railroad; also, they can have a much steeper grade than is possible with a railroad locomotive. Curves can be sharper and sudden changes of grade can be used. Therefore, in some locations where the timber is located where it is difficult to remove the timber with a train, the operator may build a truck road and haul by truck, all logs to the landing by the main-line of the railroad. At the landing the logs can be loaded onto the railroad cars and hauled over the main line to the mill.

During the summer of 1936, the C. D. Johnson Lumber Corporation had six logging trucks hauling timber from the top of a long hill to a landing by the railroad main line. The haul was about a mile-and-a-half. By using the motor trucks to do the hauling, the company saved about a dollar a thousand over what it would have cost them to put a spur-line into the timber. In 1937 the company had seven trucks operating on a similar tract of timber that would have been even more expensive to reach with a railroad. There was a seventy-five Diesel caterpillar used as a power unit to high-lead the logs to the landing. A motorized loader loaded the logs on the trucks, and the trucks hauled the logs over a mile to the railroad tracks. The caterpillar used as the power unit on the high-lead can yard on an avèrage of a hundred thousand board feet in eight hours. The cost is small, and the ease of moving the power unit from setup to setup is worthy of consideration. The caterpillar power cuts the yarding costs about in half what the same work would cost if done with donkey engines, and there are several small operators wouking within the region of Toledo, using caterpillars solely for that purpose.

Slight mention has been made of bridge work in connection with railroad construction. Bridge and trestle building is an art of its own, but because of the importance of the bridge and trestles in West-Coast logging, a more detailed study will be made. The bridge herein described is the typical kind used on the railroad location, and is of the pole-trestle design.

For the purpose of permitting the railroad to cross a ravine, creek, or deep gulch without loss of grade, some form of fill or structural support is made to hold the track, train, and load. The pile-driven trestle seems to be preferred where the fill is over twenty feet deep, or very long, or where earth is hard to obtain. In starting to drive piling for a trestle, first there is a line of levels run over the route to determine the exact elevation of the ground and grade. The two elevations are then compared, and the difference is noted. Piling can then be driven with the knowledge of the point where the poles are to be cut off. On trestles, care must be given to insure safety at all times, and as the height increases, so does the number of poles used on the construction.

On trestles under forty feet in height, four piles are driven to each bent. If the trestle is under ninety feet, but over forty feet in height, five piles are driven to each bent, if over ninety feet in height, six piles are driven. The bents are placed fourteen feet apart, and are well anchored in place. This anchorage is to prevent any displacement of the piling, and for that matter, the trestle. With adequate bracing, there is no single bent that will have to carry all of the load subjected to it at any one time.

When the pile-driving donkey engine has been brought forward, and placed into position for the driving, the first piles are driven into the ground. By means of a level instrument, the cut-off point is determined,and the piles are are sawn off. A cap, usually a twelve-by-fourteen inch by fourteen foot timber, will be placed over the piles, and fastened by twenty-inch drift bolts. Sway braces will then be spiked to the piling, and the donkey engine is ready to be moved forward. It moves itself by having a line run out through a block on a stump or tree, and then brought back to the engine sled. With this "half-block", as the arrangement is called, the power of the engine is almost doubled, and the engine pulls itself forward by tightening up on the drum that the line is rolled on.

When the pile-driver has been moved forward to the next bent, driving again takes place. The pile is raised into the air and brought into is position, and then driven with a large hammer. The hammer should be as heavy, and preferably twice as heavy as the piling that is to be driven. The hammer used at Toledo weighs four thousand pounds, and will handle piling up to twenty-four inches in the guides. Piling under ninety feet long can be driven top down. If they are longer than ninety feet long they are driven butt down. This practice is followed because a pile over ninety feet long would be too big at the butt to fit into the guides and would have to be cut down if driven from the butt.

The piles used in construction must be of good quality wood. Douglas fir is preferred because of its strength and lasting qualities, as well as its cheapness. Cedar makes the best piles, but because of the supply of cedar, and the high price of the poles, they are not used at Toledo. There must be at least eight annual rings to the inch of tree growth, no crooks, sweep of less than the radius of the pole, no rots, no pitch rings circling the pole, or any kinds of defects that would reduce its strength. These requirements are for piling used on the main-line railroad. If piling is required for spur lines, almost anything is used because the life of the line does not exceed two or three years.

On a four-pile bent there are two outside piles called the batter piles. They are driven at an angle of two inches to every foot the pile remains above ground. The other two piles are driven at an angle of one inch to the foot. If there are five piles to the bent, the same rule applies to the angles of the four outer piles, but the middle one is driven straight down, as are the two center piles on a six pile bent. The object of angling the batter piles, as they are called, is to prevent any side sway of the trestle, yet at the same time, add support to the structure.

As the work of the bridge progresses, the individual bents are braced, and then braced against each other. Girt and sash braces are used for this kind of bracing, and then panell planks are laid from cap to cap at the ends. When the bents have all been driven and braced, and the pile driver moved ahead, stringers are draged forward to be cut and placed into position. The stringers are thirty feet long. This length is great enough to permit the stringers to reach three caps, and to give a solid support for two bents.

On the two end bents of the bridge one stringer on each side of the trestle is cut in the middle so that there will be one short stringer on each side of the bridge for the first two bents. Outside of that stringer will be placed a long one reaching from the first cap to the third one. The stringers are pointed in towards the center of the trestle where it hits bent number two and three. This will permit the next long stringer placed from bent number two to four to be placed the same distance from the center of the cap as was the stringer placed on the outside at the first bent. The remainder of the stringers are placed in the same manner, so that there will be an over-lapping of the stringer just ending, and give a continuous chain of two stringers on each side of the structure with no two stringers ending on the same bent on the same side of the bridge, except at the very end s. The stringers are placed so that the weight of the rails will fall on both stringers, instead on one, and will in that manner, distribute the load over a greater bearing surface.

The material used in the construction of a trestle or other form of bridge is of standard quality for bridges, and is of good, sound material. At least of number one lumber. Piling must be free from defects. The caps are 12" x 14" x 14', the stringers are 9" x 18" x 30', sway braces and panel planks are 3" x 10" x 24', girt and sash braces are 4" x 8" x 18'. Stringers are fastened to the caps with 24" drift bolts, and the caps are fastened to the piling with 20" drift bolts. All four inch braces are fastened with ½" x 10" spikes, and the three inch braces and planks are fastened with 3/8" x 8" spikes.

Oftimes, because of errors in the cut-off of the piling, differences in the thickness of the lumber, or other causes, one stringer may be higher or lower than its neighbors. In a case of this kind it is necessary to raise the stringer, if low, by means of shims under it, or cut the bottom, if high. The stringers must be of the same elevation on their tops, except on curves where a super elevation is placed on the railroad.

When the stringers have been placed on the bents and the bolts driven, the ties are brought forward and placed on the trestle and spiked. The ties are eight feet long, and are six by eight inches in thickness and width. In spiking the ties, ten inch spikes are used, and one one side of the trestle, every other tie is spiked. On the other side of the trestle all of the unspiked ties are spiked, so that at least one spike will be in every tie. This prevents them from sliding or slipping in any direction. The ties are placed one foot center to center, or with a four inch gap between each tie. After the ties are placed, a guard rail, usually a six by eight inch plank, is spiked on the outside of the ties on both sides, and is nailed to every tie. This also adds to the support of the ties, and further holds them in place.

The rails are next brought forward, spiked, and the road is ready for traffic. A rail may be placed on the inside of the travel rails to prevent the train from jumping the track and going over the trestle, but this usually takes place only on long bridges, or on curves.

There is one precaution in the driving of a trestle, and that is the foundation. Care must be exercised in the placing of the piling to be sure that they are in the proper place,at the proper interval, secure in the ground, and will not work deeper, slip, or slide. In dirt foundations, from ten to fifteen feet should give the proper penetration for a solid drive, but the depth will depend upon a number of factors. In the first place, the piling should be driven as far as it will go. When the piling will not piling will not drive any further, less than one-half inch to the last three blows of the hammer, the required depth has been obtained. Sometimes the depth is not very great, and in a case of that kind, powder is used in the hole to make it deeper.

On rock foundations it is often necessary to drill holes and shoot them out with dynamite. When this happens, the piling rests on a solid rock foundation, and can not work deeper. Only enough depth is saught to prevent the piling from sliding out of its bed, and a shallow hole on a rock foundation does the same work that a deep hole does in dirt.

While most of the processes involved in logging transportation have been covered, the important factors, the costs, are the final determining factors that decide whether an operation is going to continue operation, or shut down. These costs are important, and every process of work figures into the total operating cost. Some of the costs are constant. That is, they do not change from year to year, or from period to period. On the other hand, there are many costs that vary slightly, and other costs that depend upon the conditions.

Of the fixed costs of an operation, the first would be taxes. Taxes would not vary with the amount or kind of logging on an area. Insurance also remains the same season after season. Some of the semi-variable factors are depreciation, fuel, the Industrial insurance, and other factors. Of the variable factors labor, repairs, kind of equipment, and others enter. All of the costs are included in logging, and through proper management, show the trend of the business.

In any logging operation in the Northwest there are two problems that have to be faced by the logging operator, over which he has no direct control. He may, and must, guard against them, and fight to keep them down, but can never completely control. They are of such importance that no attempt will be made to discuss them, other than for a brief mention as an indication that the factors are given consideration. Throughout the history of the logging industry they have been a problem to the logging operator, and to date, still confront him. Namely fires and labor troubles.

While fires may be the most expensive over a long period of time, it is the labor of today that presents the greatest problem to the logging industry. That some just settlement will be made, there is little doubt, but on the other hand, the price may be a high one to pay. The logging operator has rights, and so has labor, and it is only through a complete and proper recognition of the rights of each party concerned that any kind of settlement can be made with satisfaction on each side. Able pens have written volumes reguarding the two problems, and for now, there will be no attempt whatever to discuss them. They are important, must be guarded against, and must be considered by the logging operator if success is to be obtained in the logging industry.

LOGGING COSTS AND ACCOUNTS

MAY , 1929

LOGGING	AMOUNT	COST PER M	YEAR TO DATE
Falling & Bucking	5,388.95	$ 1.12	$ 1.16
Yarding & Loading			
Rigging ahead	1,013.76	.21	.29
Yarding & Loading	4,333.12	.90	.82
Reprs. to Eqpt.	249.00	.55	.24
" " ", Lbr.	2,622.39	.05	.08
" " rigging	242.48	.05	.05
Lubric. & oil	48.52	.01	.01
Powder	598.59	.12	.06
Wire rope exp.	1,443.85	.30	.30
Other expenses	278.89	.06	.03
Total Yard. & Load.	10,830.60	2.25	1.88
Fuel oil	2,130.16	.44	.45
Depreciation	1,043.76	.22	.25
Engineering	- - - -	- - -	.01
Total Logging	19,393.47	4.03	3.74
Railroad Operations			
Labor train crew	1,442.47	.30	.34
Lub., oil, waste	294.37	.06	.05
Total Operation	1,736.89	.36	.39
Maint. Track labor	1,806.89	.38	.37
" " material	354.81	.07	.04
" " eqpt.	123.90	.03	.03
" RR material	374.69	.08	.10
" Bridges, labor	- - - - -	- -	- -
" " material	80.48	.01	.01
Total Maintenance	2,740.77	.57	.55
SPUR CONSTRUCTION			
Engineering	- - - -	- - - -	- - -
Labor grading	494.39	.10	.04
" bridges	542.25	.12	.09
" laying steel	- - - -	- - - -	.02
" ballasting	- - - -	- - - -	- - -
Materials and supplies	1.76	- - - -	.03
Total Spur Constr.	1,038.40	.22	.18
Fuel oil	302.17	.06	.08
Depreciation	2,311.14	.48	.55
Total RR Operation	8,129.32	1.69	1.75

GENERAL CAMP EXPENSE	AMOUNT	COST PER M	YEAR TO DATE
Superintendence	456.70	$ .10	$ .11
Blacksmith shop	680.00	.14	.17
Bar iron	13.68	- -	.02
Pipe fittings	- - - -	- -	- -
Other materials	104.37	.02	- -
Shop supplies	438.99	.09	.11
Total B/S exp.	1,237.05	.25	.30
Camp expense	404.15	.09	.08
Camp lighting	138.87	.03	.05
Ind. Insurance	632.59	.13	.13
Shutdown Exp.	1,443.85	.30	.30
Sundry Expences	105.65	.02	.03
Total Camp Exp.	4,418.86	.92	1.00
Total cost of logs delivered	31,941.65	$ 6.64	$ 6.49

COST OF BUILDING A 182' TRESTLE 30' HIGH

MATERIAL

52 piling 45' long @ $ .10 per ft. .... $ 23.40

27 stringers 9" x 18" x 30'...	10,935 bd. ft.		
33 sway braces 3" x 10" x 24'..	1,980 " "		
18 girt braces 4" x 8" x 18'...	864 " "		
16 sash braces 4" x 8" x 18'...	768 " "		
22 panel planks 3" x 10" x 18'.	990 " "		
13 caps 12" x 14" x 14'	2,548 " "		
Lumber @ $20./M.	18,085 bd. ft.,	cost	$361.70

52 drift bolts 18" long @ $1\frac{1}{2}$# each.....	78#	
84 " " 24" " @ 2# "	168	
630 spikes 8" long @ .3157 # . "	200	
162 " 10" " @ .7017 # "	114	
10 % allowance for loss of spikes......	31	
Iron @ $ .05 #, wt.....	590#, cost...	$ 29.50
Powder, including powder monkey's time		10.00

Cost of all material in trestle........ $ 424.60

FIXED AND OTHER COSTS

Depreciation on the donkey	$ 2.96	per day
" " " " sled	.50	" "
" " tools, wire, etc. .	2.00	" "
Insurance on the engine	0.00	" "
Oil and grease	1.00	" "
Industrial insurance @ 7½ % payroll	29.05	in all
Water pump and hose	0.00	per day
		$ 35.51

LABOR

Hammer man	$ 7.60	per day
Fireman	6.00	" "
Foreman	10.00	" "
Pile buck	6.20	" "
Ground spike man	6.00	" "
Nigerhead man	6.20	" "
Deck man	6.20	" "
Deck man	6.20	" "
Cut-off man	6.20	" "
Overhead	....	

Labor costs per day...... $ 59.60

Time spent on bridge.... 6½ days.

COSTS

Labor..............................	$ 387.40
Materials.........................	424.60
Fixed costs......................	213.06
Total cost of bridge......	$ 1,025.06
Cost per foot......	$ 5.63