quirements necessary to handle the business expeditiously. This is again a matter of statistical organization, but it can be made to yield large results in actual operating efficiency.

The traffic department and the operating department must work hand in hand in their investigation of anticipated business, although from different motives. The traffic manager is interested primarily in car supply and train service. It is his duty to secure the largest possible number of routings of business actually in sight, and also devise means for creating business that is not in sight. His business is divided into two main classifications, local traffic and competitive traffic, and he requires daily statistics to show how his local traffic compares with his expectations or with other seasons, and it is of great importance to him to know how his local agents are handling the competitive situation. Even the local traffic is probably competitive with the traffic of other roads serving other markets, and the traffic manager must gauge the prosperity of his local industries largely in terms of their output, and this can be done only by comparative statistical data.

The intricacies of the mechanical department are perhaps most susceptible to statistical control. It deals with plain units in great variety, as for example, pounds of coal consumed per specified service as per train mile or ton mile, or locomotive miles between stoppings or axle miles per hot box. There are really myriads of details in the mechanical performance of cars and locomotives, which can be standardized by means of statistical records. And deviations from these selected or normal standards will show up in great contrast, thus plainly denoting where investigation and remedy is needed. The superintendent of motive power and his primary officers are continually engaged in these investigations.

Statistics of earnings and expenses are the ultimate check on all of the road's records, and when taken in conjunction with the statement of work performed and shown graphically, present the final picture of the system. Without knowledge of the work done, however, earnings and expenses are not an adequate means of control. Many roads west of the Mississippi River in the United States, operate for 60% of gross earnings or slightly less, while in the east the average is near 70%. Thus the operating ratio is an uncertain test of efficiency. The high rates in the newly settled parts of the country make relatively easy a showing which the best operation in the world could not accomplish in a territory of intense competition of long duration, where the struggle for business has reduced the margin of profit of the railway to a minimum. These comments apply primarily, of course, to the statistical use of the operating ratio by the banker or broker, or student of railway affairs who is trying to judge one property in terms of another. The manager of the road confronted habitually by the same set of conditions can form a great many accurate opinions from the reported earnings and they are of the highest statistical importance to him. Where detail knowledge of the property is absent, however, there could scarcely be a more perilous standard of railway efficiency than the relation which operating expenses bear to earnings. A road in mountainous country must pay relatively high sums for every ton moved, because of the necessity of double heading or of breaking up trains into short sections. On the other hand, a road operating in a swampy water level territory, as some of the roads in the Mississippi Valley do, are likely to have an abnormal maintenance cost. A road hauling large proportions of merchandise will have a high ton mile rate, but also a high ton mile cost, because of the necessity of rapid service and small tonnage in car loading. A railway operating in the cotton belt, or wheat belt, will fluctuate greatly from one season to another, while a road in Canada will report a marked increase in operating cost during winter.

Similar difficulties confront the banker and broker in making comparisons of efficiency based on the ton mile. When 1,000 tons are moved 100 miles, a service of 100,000 ton miles has been performed, regardless of the nature of the commodity. Some of the railways in Indiana and Illinois, built to haul coal, frequently produce 100,000 ton miles by moving a 4,000 ton train 25 miles, with a single locomotive and train crew. On the other hand, a road loading light manufactured articles might be doing well to load three tons per car, and in this instance it would take a single train moving approximately 1,000 miles, or 40 trains moving each 25 miles, to produce 100,000 ton miles. The worst of it from a statistical point of view is that most railways are moving a thousand different kinds of traffic all at the same time, and cannot always manage even to haul their coal and light manufactured articles in separate trains. The ton mile in consequence is an average figure composed of a multitude of dissimilar parts. This, however, does not confuse the general manager or his assistant. They have been watching the operations of each of the districts for years, and if a new superintendent on a division increases the average loading from 690 to 720 tons, they regard it as a measure of increased efficiency, because they are comparing the results of a known territory at a particular season, under known circumstances with the same territory, and circumstances in another season.

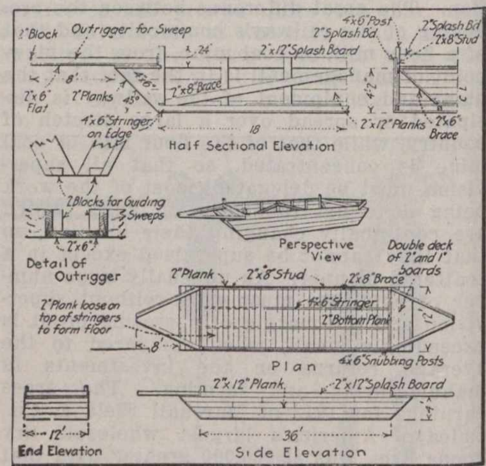
Even this discriminating use of the ton mile, when expressed in terms of average train load, often leads to its own peculiar form of error. When traffic is handled smoothly at efficient speeds, big train loads almost always mean economical operations, because they indicate that the business is being done with the fewest locomotives and train crews. But, if freight is held at terminal points longer than competitors are holding it, in order to collect maximum loading, or if the tonnage ratings are pushed to the limit, with resulting locomotive failures, blockaded traffic, overtime for crews and abnormal coal consumption, the big train load results in expensive economy. This example of an overdone economy is likely charged to statistical government, but it illustrates a point. Statistics are only of use comparatively when measured against similar performances elsewhere, or against a standard arbitrarily chosen and assigned in advance. But the analogy must be a real one. It is useless to compare results obtained with dissimilar commodities, or with the same commodities handled under different conditions of grade, curvature, and motive power.

No consideration of these statistics would be complete without mention of the effect of their use on the staff. In fact, it is possible that in many cases, even if the reports were filed away in the management's office without attention, they would really have achieved their object. If a district superintendent be made to submit an average operating figure, no matter what form the unit may take, and he is then compelled to compare it with previous periods, and the same period in the previous year, and is then asked to explain the increases or decreases, it is sure to make him think and study his territory.

The foregoing paper was read before the Canadian Railway Club, in Montreal, recently.

Contractor's Scow for the Fraser River.

In the construction of the Grand Trunk Pacific Ry. along the Fraser River, in British Columbia, the river afforded the only means of transportation for distributing plant and material to different points at which work was to be commenced. This was a dangerous service, as at high water (the only navigable condition) the river has a swift current with numerous eddies and rapids. From Tete Jaune some of the material was carried in small stern wheel river steamers built for the work by the general contractors, Foley, Welch & Stewart. But the great bulk of the machinery, material and supplies was transported in large scows, carried down by the current, and controlled by a long oar or



Scow for floating material down the Fraser River.

sweep at each end. Steam shovels, dump cars, cement, steel sheet piling, food supplies, etc., were handled in this way, and freighted for distances of 150 to 300 miles.

The accompanying plans show the construction of the scow, of which over 200 were built by the Bates & Rogers Construction Co. of Chicago, contractors for the bridge substructure work. The hull is 36 ft. long on the bottom, 44 ft. on top, 12 ft. wide and 4 ft. deep, with a carrying capacity of 20 tons. At each end is a V-shaped outrigger, with a notch in the end forming a guide for the sweep. All joints are calked. The sides can be raised 12 in. by a line of 12-in. splash boards, but these are used only in rough water or for cargoes liable to be damaged by spray.—Engineering News.

Where some roads formerly considered that a locomotive should receive a general overhauling once a year at least, with an intermediate heavy repairing as well, the time between these general repairs has been extended to two years, and the intermediate repairs are made in the locomotive house. Passenger locomotive mileages have been increased from 75,000 miles to 150,000 miles, with corresponding increases in freight mileage, and in some good water districts the boiler is now the controlling factor, rather than the machinery, as was formerly the case.

The value of uniform spacing of ties under a rail joint appears to be open to question, as observations of supported, suspended and uneven spacing of ties under joints show that all are equally effective in making the track ride well.