

Statistical Control of Railway Operations.

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In the early days of railroading, the use of statistics as a means of controlling the operations was very imperfect. Competition was not usually important and the railways were of short mileage, reaching only a limited territory. The margin of profit was large on rates amounting to only a fraction of the cost of hauling similar goods in wagons or on pack trains. But the profits of the enterprise lured much new capital. Competition became keen, lines were extended, rate wars took place and the solvency of railways soon became a matter of careful management.

The business of a railway may be divided into two distinct departments, namely, acquiring traffic and moving traffic, which is similar in industrial enterprises to the selling end and the manufacturing end. A railway manufactures and sells transportation. The great difference between the producing of the railway's commodity and that of a flour mill, or coal mine, from the viewpoint of management, is in the fact that the plant and equipment of the railway is dissipated or spread over a large stretch of country, while that of the flour mill or coal mine is concentrated, so that all supervision must be delegated, most of the work being done by transportation units, which are continually changing their location, so that they cannot be supervised except in a scattered manner. An unusually large number of employees must work without supervision and the margin of operating profit is exceedingly small, when compared to the average returns on the investments in manufacturing and farming. The gross earnings for 1913 of Marshall Field & Co., Chicago, America's largest wholesale dry goods firm, was \$2,000,000 greater than that of the Illinois Central Rd., and the interest on the investment was 14%, while that of the Illinois Central was 6%. You can well imagine the furore and condemnation and the howl of watered stock that would have been evinced, from the public and politicians, if this railway had earned 14%. The Interstate Commerce Commission would more than likely have been in night session.

As the general manager usually spends the larger portion of his time in inspection, and under normal conditions seldom directs the movements of trains, he sees but an infinitesimal volume of the company's business moved. As the scope of his vision is limited, other methods must be resorted to in order to check the operation. The means of accomplishing this is to separate the operation of the road into rigid and definite units and then to compare these units with similar ones on other roads, or with the same road at various periods, or with arbitrary standards chosen as guides, or bench marks. Controlling a railway by means of statistics might be defined as the process of determining the unit in each operation and then maintaining these units as nearly rigid as possible, seeing that they are collected, reported accurately and promptly.

The basic operating unit in freight traffic is the ton-mile, which is the product of the ton and the distance. The basic unit in passenger traffic is the passenger mile. There are six important statistical units deducible from these two fundamentals, which are defined as follows: 1. The average train load, either freight or passenger, is obtained by dividing ton mileage and passenger mileage by train mileage. 2. The average car load, freight and passenger, obtained by dividing ton mileage and pas-

senger mileage by the respective car mileage. 3. The average length of haul for passengers and freight respectively, obtained by dividing passenger mileage and ton mileage by the total number of passengers carried and the total tons moved. 4. Ton miles per locomotive hour obtained by dividing the locomotive ton miles by the number of hours the locomotives are in service. 5. The average revenue per passenger mile and per ton mile, obtained by dividing the freight receipts by ton miles and passenger receipts by passenger miles. 6. The average density of traffic per mile of road, obtained by dividing ton miles and passenger miles by the length of road. It is unfortunate that this data cannot be given to the executives earlier than 5 or 6 weeks after the operations have occurred, owing to the enormous concentration and calculations which must be resorted to in arriving at them on a large system economically. While they are of final value in determining the general efficiency of the system, it is necessary to have a more immediate check in the form of current records.

Perhaps the most tangible source of daily information is the train sheet, which is received by the train masters, and superintendents, from the dispatchers. This sheet records the movements of all trains on the division, showing their consist as to loads and empties and number of cars in the train, and sometimes shows the number of passengers carried on each of the passenger trains, as well as the general movements of traffic, the observance of schedule time, the cause of delays and weather conditions. By this means of concentrating upon a number of primary officers as much first hand detail information as they can absorb, the foundation of statistical control has been laid. The results of these primary officers' observations are collected and passed on to their next superior, who receives similar reports from many such primary officers and in this way the operations of the road and work performed is reported with diminishing detail, until the chief executive is reached.

The division superintendent is undoubtedly the most important primary officer. The operation of his territory is reported to him daily, and frequently on congested terminals he receives certain information hourly. In addition to this daily data, he has a number of statistical sheets prepared monthly, which show in condensed form, sometimes graphically, the comparative results of a large number of operations on a division, one month as against another, one day as against another, and one year as against another. When these records are graphically presented the sheets are ruled with a number of vertical lines, representing the number of days in a month, or the months in a year, or in other words, progress of time, while a horizontal ruling to scale represents volume or quantity, as is shown in the illustration. In this way the directing officer can readily see for example what has been the average tons per train mile, and the average pounds of coal consumed per 1,000 ton miles for a certain district or territory for a number of months, compared with the same months of the previous year, or if the records have been kept for a number of years fair indication will be had of the season's effect on the traffic.

The important daily returns which a superintendent receives are those showing the number of trains of loaded cars, empty cars, and total cars received and forwarded

in each direction at all of the terminals, also this same information for train movements at important intermediate points. He must know the entire train movement and the tonnage movement, and the failure to perform a given service of these movements as expressed in delays and other causes, must be thoroughly investigated and remedies applied. He is informed about the conditions of each of the yards and terminals on his division and also about outside important terminals, which may affect movements in his territory. He knows the demand for freight and passenger equipment and the class of each required at the various points, as well as the available supply, and the condition and amount of power to move it. All of this information is of a statistical nature.

The officer next superior in rank is the general superintendent. He has received through the superintendents statements showing by divisions the number of locomotives assigned, total number of through locomotives shown on the train sheets, the number of thorough freight locomotives out of a shop and available for service before a specified time, usually at midnight, the number of through freight locomotives in shop for repairs and reported as coming out within 24 hours, and those which will not be completed in 24 hours, and also the average mileage made by these locomotives in service, special locomotive assignments, such as wayfreights, passenger locomotives, switch locomotives, work trains, pick-ups, etc., together with general remarks on the entire power situation. He also receives reports on the cars handled at stations, showing the number of cars of merchandise on hand and when unloaded, together with information relating to special car movements. He is also notified concerning traffic exchange at all foreign line connections and if there is a special traffic, originating in his territory, such as coal mining, or some big manufacturing industry, he is advised of the number of cars moved and supplied, and a statement of detentions and their causes, as well as a report on the weather. While these are the principal reports he receives there are numerous special and minor statements furnished or compiled in his office daily, weekly and monthly, which are beyond the scope of this article.

It is evident that no general superintendent could exercise close watchfulness over the thousands of separate items which these reports cover, and in reality he does not. A man in this position not trained on the property could not make efficient use of them, as the information gained is not so much absolute as relative. As the great majority of the data he thus receives must be judged comparatively to be of use, the graphic method of recording statistics is perhaps most practical and is instantly read. The general superintendent, being familiar with all the conditions of his territory and knowing how it ought to operate, can look for the deviations from the results he is expecting. It may be fairly said that his system of control is by deviations from known standards.

The general manager, however, receives a smaller number of reports dealing only with the principal topics. All of these general considerations and many other local ones, the managing executives have clearly in their minds, but accurate statistical information must be the basis of their judgment in any specific case. They must receive constant advices relative to the current productive power of various localities on the system, the state of the wheat crop, the lumber market, or seaport traffic, so as to be able to foresee the possible future re-