Railway
Signaling and
Communications

Tabulation of Average Standing Time per MEET
During April 1956 on 47 Subdivisions

Average Standing Time per Meet in Minutes	Each of the 47 letters in the table below represents a corresponding subdivision T - Train orders without signaling A - Train orders with automatic block C - Centralized traffic control							
8-10	C	C						
10-12	C							
12-14	T	C	C					
14-16	T	A						
16-18	T	T	T	T	T			
18-20	T	T	T	T	T			
20-22	T	T	T	T	T	T	A	
22-24	T	T	T	T	T	T	T	T
24-26	T	T	T	T	T	T	T	T
26-28	T	T						
28-30	T							
30-32	T							
32-34								
36-38	T							
38-40	T							

Distribution chart of average standing time per meet

Tabulation of Average Standing Time per PASS
During April 1956 on 47 Subdivisions

Average Standing Time per Pass in Minutes	Each of the 47 letters in the table below represents a corresponding subdivision T - Train orders without signaling A - Train orders with automatic block C - Centralized traffic control								
10-12	C								
12-14	C	C	C						
18-20	T								
20-22	T	C							
22-24	T	T	T	A					
24-26	T	T							
26-28	T	T							
28-30	T	T	T	T	T	T	T	T	A
30-32	T	T	T						
32-34	T	T	T						
36-38	T	T	T	T	T	T	T	T	
38-40	T	T	T						
42-44	T	T	T						
46-48	T	T							
56-58	T								

Distribution chart of average standing time per pass

Why Not More Centralized Traffic Control

PROBLEM—Although railroads accepted the diesel locomotive rapidly, they have not installed centralized traffic control as extensively as they could have, simply because there is no definite yardstick by which railroad managements can foretell the benefits of proposed installations.

SOLUTION—Make detailed studies of the train operations on many divisions of numerous railroads to establish quantitative measurement of interference, and thus know how to adapt CTC to different traffic densities.

By E. P. Stephenson
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YESTERDAY talk was that diesels would replace steam locomotives. Today many railways are nearing full dieselization. Yesterday it was said that centralized traffic control some day would replace train orders. These two technological developments, which held such promise for the future, are long out of the experimental stage. One has received universal, the other rather limited acceptance, although both diesels and CTC have each received their fair share of favourable publicity. Reports on CTC have been widely circulated in both trade and railway association publications. They have been accurate, detailed and carefully documented. The installations are reported as producing what was expected of them. Yet some roads, which are closest to complete dieselization, have no CTC at all, or only a few installations on heavier traffic lines. What is holding up CTC?

The answer must be that railway managements either know that more CTC will not pay, or do not know that it will. Some installations will not pay, especially if they are too elaborate for the traffic. Decisions not to proceed with such installations are sound. On the other hand, there must be many miles of railway where CTC is warranted but the managements of the railways concerned cannot establish this to their satisfaction.

Not An Easy Task

The comparatively slow rate of installing CTC is undoubtedly related to the magnitude of the task of determining, by presently available means, adequate and economically sound designs for CTC and track facility for particular service; and the no lesser task of showing conclusively what they together will produce.

It is a frustrating experience trying to describe quantitatively what CTC and the associated track facility actually do to improve operating efficiency. This is largely because of a language inadequacy which is also reflected in the published reports on CTC. These reports are detailed, but conclusions with respect to designs and performance cannot be drawn from them, and applied to other territories. Information on operations before and after CTC must also be classified and correlated to be useful as a basis for new designs and forecasts of their performance.

To clarify the situation, some new terms must be introduced, defined and generally accepted. When they are accepted, information will be classifiable, and data accumulated and correlated for use through the industry. This would lead to more effective reporting and a better appreciation of CTC.

CTC should mean the same thing to every one. Today some confusion exists because territories are sometimes called CTC and sometimes modified CTC, without reference to the track layout, particularly siding spacing. Actually CTC is a method of controlling trains. There is an endless variety of combinations of signals and track layouts, which together comprise the "fixed operating plant." Because of the variety, there seems no alternative to calling the signals and track "the fixed operating plant" or just "plant," and qualifying the term in as much detail as the circumstances call for. The purpose of the "plant" is to provide means for handling traffic so that "interference" between trains is held within tolerable bounds for the territory to which it applies.


CTC is a method to control trains


E. P. Stephenson

How to Measure Train Interference

"Interference" manifests itself as delays to trains, and is particularly obvious when trains stand and wait for other trains at meets and passes on single track lines. A quantitative appreciation of interference was made on the Canadian National in April 1956 on 47 single-track subdivisions. Five of these were operated by CTC, two with train orders and automatic signals, and the remainder with train orders and no signaling. Data was collected on the number and duration of delays which occurred at meets and passes where freight trains were involved, i.e., a freight and a freight, or a freight and a passenger train.

Wide fluctuations were observed in the number of meets which occurred at different times and on different subdivisions. These are illustrated in the chart entitled "Daily Fluctuations of the Number of Meets for 8-Hour Intervals on 4 Typical Subdivisions." No relationship is apparent between train density and number of meets from these charts. Yet, as data was accumulated over the month from all subdivisions under study, a relationship became apparent. Between the limits of 10 and 20 trains per day it was observed that $N = \frac{T^2}{800}$ expresses the relationship with reasonable accuracy where N is number of meets involving freight trains per day per mile of track, and T is the total number of trains per day. Although the proportion varied, roughly two-thirds of all trains operated were freight trains.

In general, authorized speed for passenger trains was 60 mph; for freight trains 50 mph.

No relationship was observed between train density and number of passes. Very roughly there was one pass for ten meets. That part of the delays at meets and passes which appeared as "standing time" is shown in the distribution charts as they averaged over the month by subdivisions.

When standing time per meet "Tm" was plotted against average siding spacing "S" on CTC territory, the approximate relationship $Tm = S + 5$ was observed where "Tm" is the average standing time in minutes and "S" is the average siding spacing in miles. The relationship held, although the "plants" varied from (a) sidings equipped at both ends with power switches and full complements of signals with facilities for following moves between sidings, to (b) sidings fully equipped at one end only, the other with only a spring switch and leave siding signal and no provision for following moves between sidings.

Plotting "Tm" against the ratio "R" of distance between sidings to siding length, brought out the approximate relationship $Tm = 0.6R + 7$.

For example: say sidings are approximately one mile long, and the distance between sidings averages 6 miles, then

$$\begin{aligned} Tm &= 0.6 \times \frac{6}{1} + 7 \\ &= 3.6 + 7 = 10.6 \text{ minutes} \end{aligned}$$

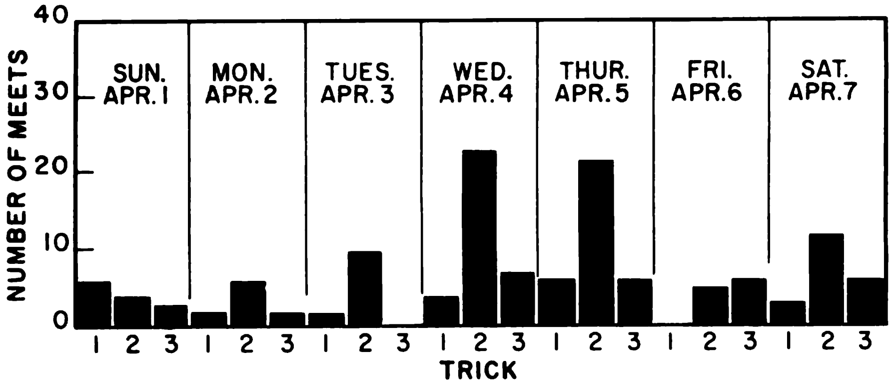
This indicates a higher degree of precision than is at present justified; so for practical purposes the answer is approximately 11 minutes.

Plotting the standing time at passes "Tp" against "D," the average distance in miles separating following movements between sidings, brought out the approximate relationship "Tp" $= 1.2D + 10$.

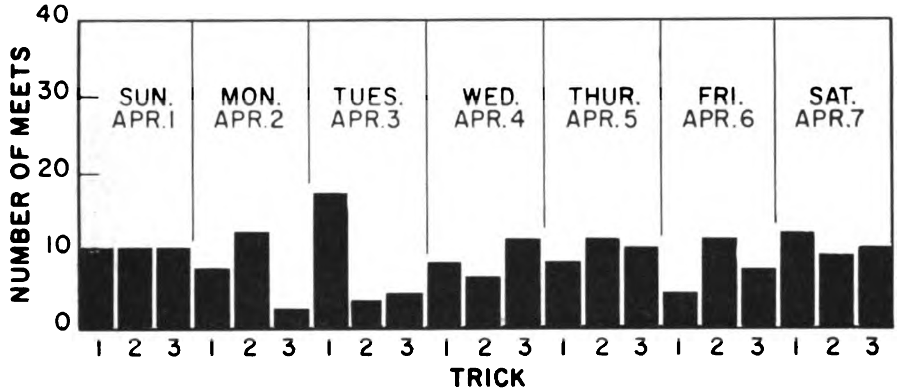
The above "Tm" and "Tp" CTC territory relationships were independent of train density within the limits of the densities encountered.

The number of meets is also a function of train speeds. At infinite speed there would be no meets. Therefore if CTC reduces standing time directly by a determinable amount, effective speed between terminals is increased with no increase in running speed, and a determinable number of meets in turn will be eliminated. Delays at

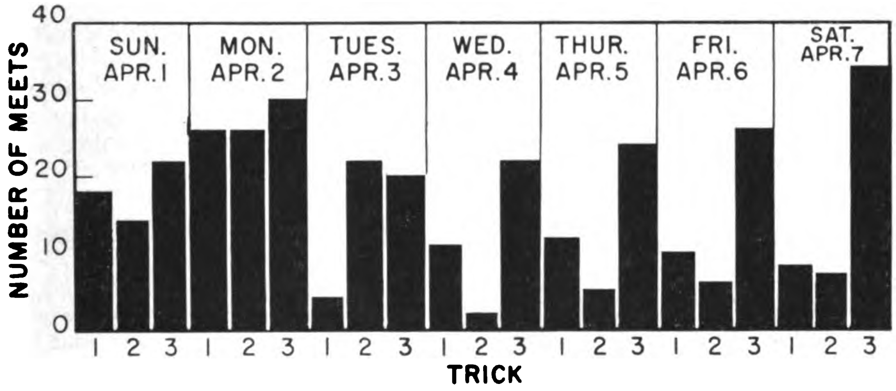
Daily Fluctuation of the Number of Meets for 8-Hour Intervals on 4 Typical Subdivisions



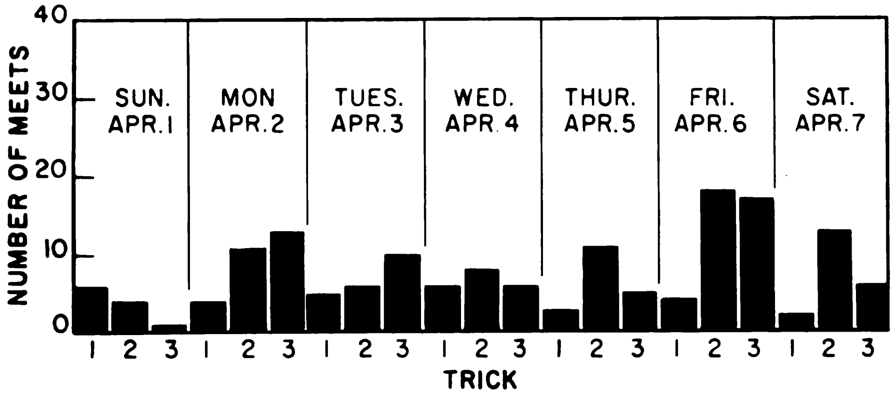
Meets on Huntsville Subdivision —115 miles—Average of 15 trains daily



Meets on Touchwood Subdivision—129 miles—Average of 18 trains daily



Meets on Caramat Subdivision—132 miles—Average of 14 trains daily



Meets on Brule Subdivision—106 miles—Average of 17 trains daily

sidings due to hand-operated switches are reduced by signals and switch machines. These reductions may be determined from speed-distance and time-distance curves prepared for various types of trains.

What About the Future

Since traffic fluctuates from day to day and season to season, and as there may be entirely different patterns in the future, for instance if shorter or longer trains are introduced, it is desirable to have a measure of the capabilities of proposed "plants" under future conditions whatever they may be. The answer to this question as well as many others, which are of vital interest in connection with train operation with or without CTC, seem more likely through statistical studies of railway operations than through any other practical way.

The concept of the amount of delay associated with each interference between trains, being a measure of the effectiveness of track arrangements and operating method, seems to point a way out of the obscurity which at present surrounds CTC. The studies of delays on the Canadian National are fairly conclusive for certain single-track lines because of the variety of territories sampled and the size of the samples. Nevertheless they should only be considered as a start in throwing more light on a major area of railway operations which needs to be better understood. The industry needs much more data on many more installations. When this data has been classified, this facet of signal engineering will become more of a science and less of an art than it is today. "Plants" may then be designed to match traffic and railway economies more closely, and also important, railways will have a new yard stick for measuring and comparing performance.

Cooperation Will Help

The cost of collecting data as described is small, compared to its value, and it is hoped that all roads with CTC in service on single and multiple track will collect and correlate such information, and make it available. They owe it to themselves and the industry to take advantage of the earning potential of CTC. Fuller exploitation of that potential will be possible when more pertinent statistical data is available.