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How train station name signs should be installed

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The legibility of train station name signs was analyzed with parallel (0°) and perpendicular (90°) installations regarding different speeds, different lateral offsets, and different widths of the signs. The theoretical analysis resulted in the superiority of perpendicular installations for short lateral offsets from the platform edge (3 m), and a superiority of parallel installations for large offsets (50 m). Sign width effected legibility nearly proportionally, higher speed reduced legibility inversely proportional. In the empirical part, the superiority of the perpendicular installation at short lateral offsets was supported. From a moving train, legibility of perpendicular signs is superior while during a full stop, parallel installations are advantageous. Thus, as a compromise, parallel installations should be used within the inner circle of a train station while at the entry and exit where trains are still moving, perpendicular signs should be preferred.

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1. Introduction

Train station name signs are important aids for better way finding. Particularly those railway passengers who travel to unknown places would like to be informed when the destination station is approaching. Stopovers at some stations are short and there may be not enough time to collect the luggage in the very last moment. Thus, train passengers need to be informed timely. Consequently, station name signs should not only be legible from a stationary position, however, they should be detectible and legible from a moving train as well.

Some research articles and reports are available regarding the usability mostly of on-premise signs (Bertucci, 2003; Garvey, 2006; Zineddin et al., 2005). Research has been done on size (Bertucci, 2006; Forbes and Holmes, 1939), color, and font of destination signs. It has been found that the maximum distance from which the names still can be read is 30 times the height of the capital letters of the name of the place (Arthur and Passini, 1992). As a result, most of these names are written in a font with a height of about 15 cm–30 cm, which makes the sign still readable at a distances of about 50 m and more (1 inch = 2.54 cm, 1 m = 3.28 feet). As well, the effects of the driving speed of cars (Bertucci, 2003) have been evaluated, as has the effect of parallel or perpendicular installation of the signs (Zineddin et al., 2005). In most of these cases, the signs could be viewed through the front window of cars. However, train passengers cannot look out of the front but only through the side window, and the window frame reduces the maximum distance for readability if one does not flatten one's nose at the windowpane.

Regulations for signage of station names mostly concern type fonts and letter size (FIS (Switzerland), n.d.; "Informations-und Wegeleitsystem (ÖBB Austria)," n.d.). Only one regulation was found regarding parallel or

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perpendicular installations. In 1930, a German provision recognized that parallel station name signs are less readable from fast moving trains and thus, some signs should be installed in a perpendicular way as well. These perpendicular signs should be mounted at the ends of the station platform and parallel signs in between (Naweba, 1930: §4). An older perpendicular and a more recent parallel example can be seen in Frankfurt ("Frankfurt perpendicular," n.d.; "Frankfurt parallel," n.d.). In Austria as well, it seems that in the recent past, parallel installations were preferred although there are examples of older perpendicular signs. A simultaneous installations can be seen from "Spittal" (n.d.). In Austria and Germany, however, parallel mountings seem to be more common these days. An exception is Switzerland where both parallel and perpendicular installations can be found frequently ("Rothenbrunnen parallel," n.d., "Rothenbrunnen perpendicular," n.d.).

These examples demonstrate the awareness of the installation problem, however, a thorough investigation has not been done yet. The contribution of this research note is the analysis of the legibility and readability of station name signs from moving trains with due regard to the installation angle. Both theoretical and empirical studies have been conducted. At the beginning, results from a survey in Germany regarding the importance of station name signs are reported. Thereafter, a mathematical analysis tries to find optimal solutions theoretically. Finally, results from the same Germany survey regarding legibility and readability of different sign installations will be presented.

2. The importance of station name signs

In a German online survey conducted in 2012, respondents were asked several questions regarding trains and train station name signs. A well-known German provider (promio.net) invited 5000 members out of his panel consisting of 150,000 consumers by emails. Panel members were distributed according to the demographic structure of Germany across gender, income, regions, and age. In total, 767 respondents participated (39.5% female, $M_{\text{Age}} = 43.7$ years, $SD_{\text{Age}} = 12.7$ years). Only 10% stated never to travel by train. Most of the others found station name signs important and looked out for them. According to their opinion, such signs could hardly be replaced by train crew messages or navigation tools on smartphones. Although only few stated that they had ever missed a station because they had overlooked that it was their destination, passengers occasionally did not know the name of the next station. Hence, station name signs are indispensable and they have to be legible from a moving train. If the signs are only legible in a stationary position and in case this station is the destination, it may be too late to collect the luggage and to leave the train in time. Distribution of answers can be seen from Fig. 1.

3. Theoretical model

The situation under investigation in this study is a passenger sitting near the left edge of a window facing the engine. Results will be valid for passengers with one's back to the engine as well, using reverse calculations. Fig. 2 depicts the situation assuming a passenger sitting facing the engine at a distance of 0.15 m from the left side of the train window having a width of 1.4 m, looking in the direction of a station name sign positioned at a lateral offset of 3 m from the embankment. It can be seen that the view is blocked due to the window frame, and detectability of the sign starts at around a 30-meter distance with a viewing angle of about 6°.

Fig. 3 shows the installation of a sign on an island platform.

As can be seen in Fig. 4, the tangent of the projection angle γ causes the sign to be depicted on the observer's retina, and thus the size of γ determines the visibility. The size of γ is the difference of the angle between the viewing directions toward the left (α) and right (β) edge of the sign. As has been discussed in the literature, signs can be installed parallel or perpendicular to the direction of traffic (Zineddin et al., 2005). Intermediate angles as depicted in Fig. 4 have not yet been analyzed.

The projection angle γ, however, is not the only determining measure for legibility. Because the train moves, the angular velocity increases during approach toward the sign, which leads to an inferior legibility. The angular velocity is defined as $\omega = \text{speed/radius}$.[1] The radius can be approximated by the linear distance from the observer to the sign's midpoint, according to the Pythagorean theorem. Thus, $\omega = \frac{v}{\sqrt{d^2+l^2}}$.

As shown in Fig. 1, legibility starts at about 30 m from the sign. The decreasing size of the afterimage of the picture depending on higher distances can be neglected due to Emmert's law of size constancy (Boring, 1940; Edwards and Boring, 1951; Nakamizo and Imamura, 2004). Although the afterimage of a person at a distance of 30 m is much smaller than the one at only 3 m, the human visual system corrects for the distance, and the objects are perceived as equal in size. Thus, the legibility defined as the projection angle divided by the angular velocity is calculated for two situations:

[1] Correctly, the speed should be the orbital velocity on the circular path around the pivot which is only a component of the train speed v, defined by the sine of the viewing angle $\left(\vec{v} = v \cdot \sin\left(\frac{\alpha+\beta}{2}\right)\right)$. With longer distances, however, viewing angles are small and the sines are small as well. Thus, with this value in the denominator, the legibility will be overestimated for longer distances (see Equations (1) and (2)). Additionally, it is the train speed itself that diminishes legibility (with a speed of 100 km/h, the train passes 30 m within a bit more than a second, with only 10 km/h, more than 10 s remain to read the sign). For parsimonious reasons, the inclusion of an additional orbital speed was omitted. This means no disadvantage for short distances since there, the sine approaches 1 and the orbital velocity approaches v.

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