

# Predicting workload in railway signalling

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## SUMMARY

Upgrades to railway timetables, track infrastructure or signalling systems can generate increased workload for signallers and it is important to predict the scale of this in order to avoid overload, which can lead to reduced performance and therefore safety issues. This paper describes the development of an Excel based model to predict the effect of these changes, to allow for possible issues to be spotted and resolved.

## KEYWORDS

workload, railway signalling, predictive models

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## Background

Within the railway, signallers control the movement of trains on the network. This is predominantly completed using different types of software that allows for the remote control of points and signals (Balfe, et al., 2015). Due to the volume of trains on the network signallers can experience periods of high workload, which can be exacerbated when unexpected events occur. This can lead to overload which may increase the potential for signallers to make mistakes or errors (Young, et al., 2015). It is vital that the control interfaces offered to signallers support efficient and effective working to avoid further additions to their workload burden.

This paper presents a methodology that has been developed to allow signaller workload to be modelled based on three elements: the infrastructure, the timetable, and the control system in use. The model therefore facilitates the prediction of workload based on changes to any of these three elements. This will be used to help predict workload changes for the incoming signalling system.

## Method

The model created uses the train timetable and infrastructure information from the controlled section of track (e.g., points and controlled signals) to predict the total workload imposed on a signaller over a specified period. Each infrastructure element has time values associated for any train movement over or past it. An initial model was created using estimates of these values, based on data from previous observational workload assessments on the same type of workstation.

To update and validate the model, a series of six observations were carried out at two different signal cabins. The signal cabins selected were chosen due to the infrastructure found on the track they controlled and the volume of trains; the relatively small amount of these allowed for easier initial quantifying of track infrastructure and system interactions. These observations were carried out with multiple different signallers to ensure the model was not specific for one user.

The observation information was used to produce an overall time-occupancy profile of total workload during the period. This profile was used to allow a set of incremental changes to be made to the timings for each action category. Each model iteration was then compared to the workload for each observation period to assess their accuracy, until a suitable level was achieved.

## Results

The number of signals were used, among other track features, to predict the time spent planning for, interacting with and monitoring the software, for each train planned over the track section. A prediction for the time carrying out telephone communications was based upon the number of trains expected and the time for responding to system alarms was based on trains reaching their terminus or turning around. These categories allowed an estimate of total workload to be produced (Balfe, 2010). Table 1 describes some of the timing data included in the model.

Table 1: A simplified version of how workload was predicted for a section of track

Infrastructure Element	Element Count	Monitoring (sec)	Interaction (sec)	Planning (sec)	Trains on section	Total workload (sec)
Controlled signals	6	2	3	2	2	84
Points	3	3	2	2	2	42
Level Crossings	1	2	2	2	2	12
Track circuits	12	1	0	0	2	24
<b>Total for track section during observation:</b>						162

Based on these values, the model produces a set of predictions for signaller workload; Table 2 includes the recorded values from some of the observations and the predicted values using the model. A precise replication of the observations cannot be consistently achieved with this method, but the model does consistently generate predictions which are close to the real observed workload.

Table 2: Comparison of the predicted time occupancy and real values

Signal Cabin	Date	Times	Predicted Time Occupied (PC-ECP)	Real Time Occupied (PC-ECP)
A	23/01/2025	07:22:21 - 09:00:03	26%	18%
A	18/04/2025	16:32:59 - 17:45:30	34%	29%
B	13/08/2025	14:21:54 - 16:25:05	16%	22%

## Discussion and conclusions

The predictive model has shown that it can produce estimates of signaller workload which are broadly in line with observed values. The overall predicted time occupancy was consistently within 10% of the real time occupancy value. It is not expected to precisely replicate real data, due to day-to-day variabilities which the model cannot account for. To date, this has been modelled across two workstations, but future work will validate the model on more complex workstations by using data from further observations.

The purpose of the model is to enable the rapid assessment of future workload for proposed changes. As it is Excel based, the model facilitates easy and relatively quick assessment of workload ahead of the commissioning of changes. These could include:

- Timetable changes which impose additional tasks and actions on the signaller. The model allows these to be assessed by running additional trains through the model.
- Infrastructure changes which create more complex control areas (Pickup, et al., 2005). The model allows these to be assessed by creating additional infrastructure elements and associated timings within the model.
- New or changed control systems. The model allows these to be assessed by changing the timings associated with infrastructure elements. For example, a future extension of the

model will incorporate timings on workstations with Automatic Route Setting (ARS) and with Traffic Management Systems (TMS).

## References

- Balfe, N. (2010). *Appropriate Automation of Rail Signalling Systems: A Human Factors Study*. Nottingham.
- Balfe, N., Sharples, S., & Wilson, J. R. (2015). *Impact of automation: Measurement of performance, workload and behaviour in a complex control environment*. Dublin: Elsevier.
- Pickup, L., Wilson, J. R., Sharples, S., Norris, B., Clarke, T., & Young, M. S. (2005). Fundamental examination of mental workload in the rail industry. *Theoretical Issues in Ergonomics Science*, 463–482.
- Young, M., Brookhuis, K., Wickens, C., & Hancock, P. (2015). State of science: mental workload in ergonomics. *Ergonomics*, 1-17.