D-MOD Dynamic Modelling of Operator Demand
A new simulator module for the evaluation of signaller's demand

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Abstract: Estimating demand in signalling operations can inform both decisions about current operational practice as well as future technology. The ideal situation is to have a flexible, automated tool that can estimate demand parameters based on models of timetable and infrastructure to capture dynamic (as opposed to static or averaged) characteristics of a workstation. The Dynamic Modelling of Operator Demand (D-MOD) project has developed a new workstation evaluation tool by drawing on existing simulation models of traffic, timetable and infrastructure. This paper presents the first phase of work to dynamically model parameters from an existing paper based tool showing savings of time and effort, and highlighting directions for future dynamic demand modelling.

Keywords. Railway Traffic Dispatcher – Workload Prediction – Demand – Simulator

1. Introduction

Rail industry stakeholders and human factors professionals have a need to predict the demands on the operational staff regulating rail traffic. In the case of signalling and traffic control, this means understanding both how operational conditions in the short-term such as the introduction of a new timetable might affect demand, and also the more effect of future technology such as European Traffic Control System (ETCS) and Traffic Management System (TMS). While tools such as the Operational Demand Checklist (ODEC) (Pickup et al., 2010) can capture static and averaged (e.g. maximum number of train/day) statistics, they do not capture more dynamic features of demand. This includes identifying points where sources of demand may occur concurrently, or even interact.
In theory, by running a simulated model of the timetable and traffic, running over an accurate model of the timetable, it should be possible to calculate a number of dynamic demand parameters relevant to signaller work. Such models exist as part of high fidelity signalling simulators used, amongst other things, for training. The work in this paper exploits these models to derive dynamic demand estimates and, in the process, provides a path to refine and evaluate more nuanced models of operator demand now, and for the future. This includes modelling the impact of automatic route setting (ARS) and various Human Machine Interface (HMI) configurations. One major challenge will consist of capturing the ranges of values associated to representative demand parameters.

2. Method

Our study started with a wide exploration of existing HF tools in the railway and other domains, capable to evaluate workload related with task demands. In parallel, an internal study on demand parameters was performed with signalling experts from HICSE. In the context of our project, the requirements linked with the simulator called TREsim implied that the new module D-MOD include parameters related with the infrastructure, timetable and technology – as these are data with which the simulator is actually working. The analysis of the simulation tools oriented us toward ODEC which provides an indication of task demand with an acceptable level of granularity for our proof of concept. Many parameters are quantifiable and the method has been validated and is in routine use, but some parameters in ODEC are approximate and do not always reflect the dynamic tasks of a signaller in relation with its changing working environment. Therefore, ODEC gave a candidate set of parameters but with scope for adaptation into new parameters more representative of dynamic traffic patterns.

3. Results

A proof of concept has been successfully developed and tested. This pilot integrates the calculation of ODEC parameters for any workstation and timetable containing ARS data. In addition to standard ODEC parameters, it has already been possible to produce more sensitive, dynamic measures including speed variations, number of route settings, number of trains on signaller's workstation, for a 24h timetable and comparisons of theoretical timetable against actual running traffic. The first benefits of this basic release are (1) cost effectiveness in terms time savings – less time required to perform an ODEC evaluation, visibility on results (2) the interface provides results on the overall workstation but can also focus on subareas selected by the end-user in case a dedicated study of a specific area is required, realistic (3) based on real dynamic data generated from the simulator and its interpretation of the timetable, the results of the study guarantee a high fidelity demand simulation.

4. Future work

One can discuss the quantitative method used for the module: indeed demand reflects an objective value of a potential complexity but maybe lacks of meaning in specific contexts, especially underload situations, where a phenomenon of dissociation can be experienced (Young et al., 2015) (workload level is not always aligned with demand level – thus demands cannot always be related with workload). Thus, other methods (experimental, qualitative or physiological) may be useful to complement the module in the future. Another fact to be discussed are the demand levels and their associated ranges (High – Medium – Low), which can be very specific to the studied area. Are the experts' inputs sufficient to determine them? Shall these levels remain fixed or dependant to their associated workstation? Finally, several parameters have been integrated into the module: do these parameters, and their formula, provide an accurate overview of the situation? All of the above are currently being explored with a panel of industry stakeholders and researchers to derive future requirements during "demand working group" meetings.

References

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