ARUP

Designing effective signalling systems with confidence

Rail Signalling Visualisation Tool

www.arup.com

Why use Arup's Rail Signalling Visualisation Tool (RSVT)?

Efficiency
The RSVT makes the signalling design process more efficient.

Quality
The RSVT improves the quality of rail signalling design.

Safety
The RSVT enhances operational safety of signalling systems.

Design engineers typically produce schematic drawings of the physical objects located along the track to design the layout of rail signalling systems. They rely on a set of technical rules and conduct reviews together with railway owners and operators to arrive at a signalling layout that supports safe and efficient train movements.

Expectations for the train movement and more importantly, how the train driver will read and respond to the signalling scheme are major components of system safety and operability.

They are captured during the design review stage, using videos recorded from the cab of trains and, more recently, static design models in combination with schematic drawings. But this information is quite fragmented and does not convey exactly how the system will look and feel from the driver's perspective.

A typical schematic drawing.

Making the most of in-cab signalling systems

Thanks to modern in-cab signalling systems such as the European Train Control System (ETCS), drivers receive signalling information through a dynamic display inside the cab. The display adapts to train type and behaviour, responding to dynamic elements such as the speed of the train and driver actions such as braking and acknowledging alerts.

Existing design review technology, however, does not allow design engineers to easily visualise the effects that these dynamic elements will have on drivers, nor adequately relate them to when they are delivered or to the train's position in relation to the outside world.

Visualising the signalling design process

The RSVT developed by Arup in partnership with Graffica allows design engineers to assess how drivers see and respond to in-cab signalling information to ensure that they receive the right information, in the right format, at the right time.

The RSVT displays a representative 'look and feel' of the train driver's in-cab view.

The RSVT allows design engineers and railway owners and operators to fully understand and evaluate at an early stage of the design process how the system will behave in the context of its surroundings. The system displays a representative 'look and feel' of the train driver's in-cab view, including real-time changes on the ETCS' driver machine interface (DMI).

Train movements are calculated to represent the operational line speeds and motions over various operating scenarios. These scenarios can be recorded, making it possible to systematically review videos offline to capture the interactions between the driver and the rail system, leading to a fuller understanding of the demands the ETCS places on the driver and any potentially conflicting tasks that may materialise.

Information from the RSVT is used to validate the ETCS design and make any necessary adjustments to ensure that the design of the signalling scheme supports drivers to deliver safe and effective performance.

A better approach for system design

When setting out to design a rail signalling system using the RSVT, Arup will create a coordinated model that relies on collected inputs such as:

– Geographical information from photography, LiDAR surveys and videos of the line

– Design models for new or upgraded infrastructure elements such as track alignment, overhead equipment and bridges

– Client-specific technical requirements, siting forms and other signalling inputs.

The coordinated model is used to design a virtual environment that reflects both system behaviour and the outside world the signals will help navigate. Scenarios will be created to allow the design engineers, railway owners and operators to explore and interact with the system.

We will generate three outputs:

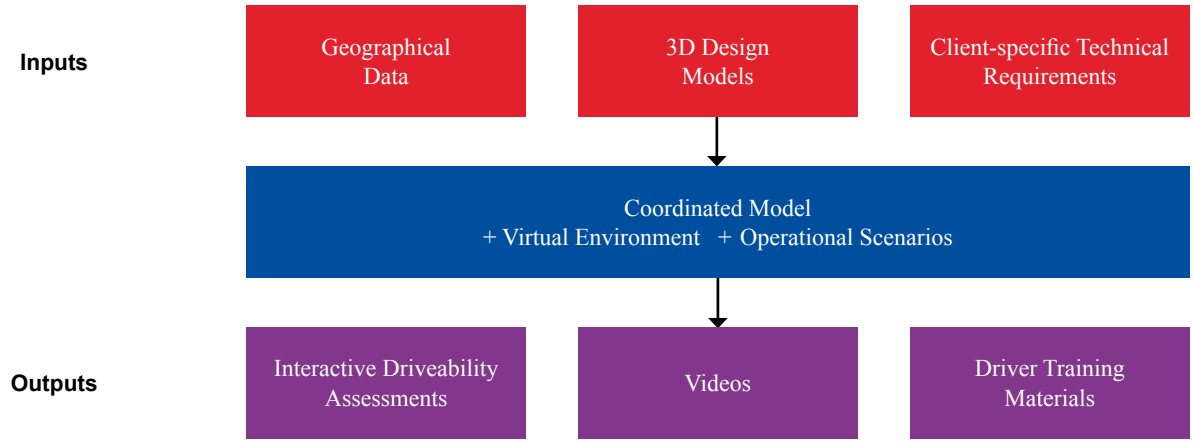
– Interactive driveability simulations that allow railway operators or train drivers to assess the signalling system in an office environment

– Videos that visualise the real environment along a rail route, enabling railway operators to review the signalling design for acceptance

– Training materials that allow drivers to undergo training in different scenarios and to refresh drivers' familiarity with the line once the project is completed.

Design changes and updates can be implemented rapidly as feedback is gathered and the system design progresses.

How the RSVT is used to support better design and evaluation of signalling systems



Why the RSVT makes for faster and better designs

The RSVT has a range of benefits:

It creates a collaborative environment where railway operators' views are included in the design process.

It facilitates the early identification and effective resolution of problems.

It minimises the risk of substantial objections and late changes delaying entry into service.

It enhances the efficiency and operational safety of new signalling systems.

"Working across a number of ETCS projects within the UK including TRU, the RSVT has enabled both train operators and the signal design team to see first-hand what the driver sees on the trackside and within the driving cab on the ETCS DMI. It has also allowed any changes to be viewed and corrected before there is any need to go trackside. Another benefit is it enables users of the ETCS DMI in the future to see first-hand the interaction between the trackside and train along a route that the user works over, instead of trying to imagine what the indications on the DMI looks like with looking over a scheme plan. In my view the RSVT should be taken forward by ETCS projects as Best Practice."

Ron Bailes, Projects Director, Rail Operations (UK) Limited

RSVT in the real world – Transpennine Route Upgrade

As part of the Transpennine Route Upgrade (TRU), UK railway owner Network Rail is installing ETCS signalling in sections of the route connecting cities in the north of the country. This involves removing lineside signals and using an in-cab display on some sections of the route.

Network Rail appointed the TRU West Alliance in 2021 to carry out design development for the ETCS signalling in sections of the Transpennine Route. Arup, being the lead design partner on TRU West, led this development. The traditional method of communicating design through drawings was no longer sufficient as it could not capture the driver's interaction with the in-cab system. Superimposing information on route videos was not feasible either, given the complexity of the system and the significant changes in the railway route and surrounding landscape. In order to gain Network Rail's approval, it was necessary to apply a new approach that enables appropriate evaluation of the dynamic behaviour introduced by the ETCS signalling.

We used the RSVT to help design the ETCS signalling in sections of the Transpennine Route.

We created an interactive visualisation environment that underpins the driveability assessment approach, resulting in a number of benefits to operations, human factors, and safety and performance analysis. The RSVT provided a high-resolution rendering of the real world along the Transpennine Route while visualising the infrastructure to be added to the route in the future using BIM digital models. The tool has resolved initial concerns about some design features, such as level transitions, and enabled operators of the Transpennine Route to focus on problems such as speed changes and the relative location of degraded operation signage.

The RSVT brought immediate benefits to the signalling design process:

– The ability to 'test-drive' the design before finalisation, offering opportunities to identify and address dynamic behavioural issues much earlier in the design lifecycle.

– The ability to 'see' the whole future rail corridor including changes to bridges, track layout and stations – an innovative feature in a sector where infrastructure changes and signalling scheme design are not traditionally undertaken at the same time.

The use of this technology has ensured that operational feedback informs design development from the earliest stages. We have worked with Network Rail and railway operators to interrogate the design and address more effectively the positioning of transitions and signage – in normal and degraded modes. Detailed task and error analysis has allowed us to understand the impact of transition locations in the context of the route.

The use of the RSVT has made it possible to achieve greater operational engagement than traditional approaches to driveability assessments. It has not only helped improve the ETCS signalling design, but has been used to generate driver familiarisation materials for the sections that use conventional signalling.

Please scan this QR code to know more about the RSVT:

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