

### Better Change

Moving goalposts can seem like a fact of life in rail engineering. Nobody wants their project requirements to change in the middle of their work, but it happens to everyone. And even if the objectives remain stable, there is always the risk that changes in the network during the life cycle of the asset could necessitate going back to the drawing board.

Systems Engineering (SE) can help make rail engineering more adaptable to these kinds of change, and mitigate the associated costs, both by making it easier to anticipate these risks before they arise, and by making it easier to change course when new requirements do come out of the blue.

SE stakeholder engagement processes may by themselves significantly reduce the risk of such project change, simply by virtue of providing a better and more comprehensive understanding of the project objectives at the outset. But no process can pull information out of the void when it doesn't exist, and when a change in direction is unavoidable, SE can also help a rail project adapt to that change more quickly and seamlessly.

Using good SE practice generates a solid and adaptable bank of information about a project's objectives, design, workflow, implementation and testing. If the project requirements change when work is already underway, the structure of this information makes it far easier to interpret the effect of this change on the project as a whole.

Many unexpected interactions with other requirements, as well as pressures on schedule and budget, will be immediately visible through requirements management practices and the project model. The change will be immediately promulgated to all relevant teams, who would be working from the same single source of truth, allowing both direct employees and partner organisations to immediately assess the impact of the change on their plans. And any new verification and validation standards implied by the change will not be ignored, as these are tied directly into the specific and measurable project requirements.

Furthermore, with sound knowledge management supporting SE activity, this project information can be retained throughout the life cycle of the asset, and if any midlife upgrades are necessary, it becomes much easier to make those changes without reinventing the wheel.

All rail assets exist as part of a larger system, and successful rail engineering needs to understand not just how its asset fits into that system as it stands, but how it will react as the system changes in the future.

The introduction of cab signalling on the Great Britain (GB) network shows that even rolling stock needs to be able to adapt to the changing systems of the network, to say nothing of future pressures from accessibility and decarbonisation.

Network-wide systems like control, command and signalling also have a great deal of complexity and emergent behaviour in their own right and exist in a constant state of flux; never more than now.

As rail systems become more complex, the risks associated with project change become more difficult to manage. Different components in the network interact in increasingly complicated ways. Keeping sight of the big picture while the individual parts adapt to new technologies is a critical mitigation of risk.

### The SWORD Project: Smoothing the Impact of Change

Network Rail's 'Digital Railway' programme is a large-scale overhaul of the entire network's Control, Command and Signalling (CCS) systems, with the potential to hugely increase the safe capacity of the network while reducing cost.



The programme will ultimately replace every lineside signal on the network with cab signalling systems, but in the meantime, some existing infrastructure will reach the end of its life and require immediate replacement.

The SWORD (Self-powered Wirelessly Operated Distant signal) project was the result of exploring cost-effective options for these 'temporary' signals. The idea was to remove the need for long lengths of fixed copper cable between the signal and its control point.

At the time, model-based systems engineering and simulation-based validation were relatively new approaches to Network Rail and CCS, but there was a need to verify and validate the SWORD system more quickly, cheaply and safely than would have been possible with a traditional prototype.

By building a systems engineering model of SWORD, Network Rail was able to validate the system through simulated testing, produce a better specification for stakeholders, ensure end-to-end traceability of the system, and maintain an adaptable model for any future specification changes.

*This case study was adapted from "Verification and Validation of a new type of Railway Signal using MBSE and Simulation", Stephenson, Vine & Towers, November 2018.*

## The Value of Transparency

Transparent, real-time information on a project is critical to ensuring that it is being delivered on spec, on time and on budget, and traditional tools have often been of limited use in providing that, especially when a project is being delivered through or assisted by multiple subcontractors or a complex supply chain.

Systems engineers have developed many procedures and tools for managing project information in a way that guarantees rigour in objectives, process and quality assurance. Research has shown that systems engineering activity has a significant, quantifiable return on investment, which can be as high as 7:1 in projects where little or no systems engineering activity has been employed at all.<sup>1</sup>

What's more, systems engineering tools can help with project control, and ensure work is delivering the value it was planned to deliver. By making processes more transparent to ongoing value engineering, not just for the full duration of work, but throughout the full life cycle of the assets, these tools can help engineering enhance quality, mitigate risk and lower costs.

<sup>1</sup> Honour, Eric. "Systems engineering return on investment", PhD diss. University of South Australia.

These tools enable the maintenance of a single source of truth about the project, which persists not just along the full life cycle of the project but across all stakeholders and partners who are working to achieve it. By moving these tools into the cloud and enabling cross-compatibility, different teams, including those from partner organisations, can all feed into and draw from the same, real-time feed of project information.

Delivering value is easier and less risky when those who need to know have a clear picture of what's actually going on.

**This information sheet is an excerpt from SyntheSys Technologies White Paper about Engineering a Better Railway for Northern Ireland. [Read the full White Paper \[here\]](#).**

## About SyntheSys

SyntheSys provides defence systems, training, systems and software engineering and technical management services over a spectrum of different industry sectors. Along with distinct support and consultancy services, our innovative product range makes us first choice provider for both large and small organisations. Established in 1988, the company focus is on fusing technical expertise with intuitive software applications to solve common industry challenges.

