

Right first time: Systems engineering in rail

Arvinder Sangha, Senior Systems Consultant

As Network Rail's Digital Railway strategy spells out, digital transformation is urgently needed to improve the passenger experience and bring down the operating costs of the rail network.

There's no doubt that, if you get it right, the benefits are immense. Increased efficiency improves performance for passengers and freight customers, resulting in faster journey times, enhanced safety and greater data connectivity. Improved asset sustainability reduces whole-life costs. Digital currency futureproofs organisations and enables them to keep pace with demand.

THE SYSTEMS SOLUTION

At Harmonic, our experience of helping to deliver major digital transformation programmes in rail, aerospace and defence has clearly demonstrated the value of taking a systems engineering approach.

All too often, programmes end up firefighting in the latter stages of delivery. Bringing systems together is a necessary evil of delivering programmes in rail – and it's notoriously difficult. If undesirable emergent behaviour is foreseen it can be fixed easily, but this is difficult with traditional non-systems approaches, tools and techniques.

This is where systems engineering comes in. Rather than waiting for the fires to start and relying on a fire extinguisher, it shows you in advance where the flammable risks are and removes or mitigates them. Essentially, we highlight the problem areas sooner rather than walking into that burning building. In exchange for a bit of

upfront effort, it delivers a faster, cheaper and better approach that gets programmes right first time and reduces firefighting.

At Harmonic, we favour a model-based systems engineering (MBSE) approach – a technique used extensively in industries such as aerospace, defence and automotive, as well as increasingly in rail.

This was first championed by INCOSE in 2007 as engineering disciplines began the long-term move away from document-centric approaches to model-centric ones.

It all sounds very complicated, but what does it mean in practice?



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MODEL BEHAVIOUR

MBSE is a holistic approach. It means taking a step back, thinking in the abstract, and looking at the problem from different perspectives. It considers the full lifecycle of the project: rather than just an initial programme delivery, it's thinking from cradle to grave – from a futureproofed design through the lifecycle to the disposal of the system.

As system complexity increases, undesirable emergent behaviour will also increase. There is no magic method to pull all potential emergent behaviours and properties from a system. What is required is upfront effort and a considered, measured, analytical approach. Having an agreed framework in place allows for a more rigorous and efficient programme, developing a blueprint for success and a lasting capability for future change.

Tools and techniques such as user stories, use case modelling and development of concept of operations can all help us to build a model of the system. It doesn't have to be a complex model – in fact it's more about breaking down the complexity into simpler elements.

The beauty of the MBSE approach is that the language used is clear and concise. Models are developed at a high level; they're clearly understandable for all parties and stakeholders involved. More detailed models can be developed later down the line, as and when required, with traceability between the different models.

But most importantly, MBSE shows the path from business needs through to detailed design and the delivered solution. At Harmonic, our solutions architects connect business needs and processes to technology solutions. We build a map and ensure our holistic approach produces a coherent solution that considers everything: process, organisation, people, tools, technology, and information.

This approach not only benefits the programme in hand, but provides a blueprint for future change as well.



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Arvinder Sangha is a Senior Systems Consultant at Harmonic Ltd and has supported a range of clients in the rail sector with technical programme delivery. A TOGAF-certified enterprise architect, he has over 10 years' industry experience in systems engineering. Recent rail experience includes delivering mid-life system upgrades across an existing fleet of units while they were still in service. This article is based on a talk Arv gave at RIA's Unlocking Innovation event in May 2021.

MBSE AND TECHNOLOGY

Whether it's software, hardware or a service, it is particularly beneficial for technology programmes to be treated as a whole system, from birth through to disposal. Taking the MBSE approach to digital transformation highlights and identifies similarities across the entire system, develops a more coherent design, pulls out efficiencies and supports their reuse. During the design phase, it can also help to reduce the training burden and ensure that a rigorous testing regime is built up.

Integrating legacy systems and developing interfaces is a key area that is often overlooked and needs to be managed. The nature of the rail industry means that innovations often have to be integrated with old machinery that is moving towards obsolescence. A systems engineering approach can help solve the problem of integrating multiple systems of differing ages and levels of technological sophistication, creating a holistic implementation with an end-to-end perspective. Using a vertical architecture rather than a layered one allows for reuse of common software functions.

Our experience of working with suppliers and subject matter experts introducing new technology and software in the rail industry has also revealed the importance of rigorous control and governance around all of these activities. There are novel solutions being developed, however they need to be adapted for rail-specific needs.

DELIVERING VALUE

Our experience suggests that the rail industry needs a change of mindset. Sub-optimal solutions that leave long-term issues for the end users to manage are not acceptable. When it comes to digital transformation the sector needs to adopt a flexible approach, looking at all types of requirements and considerations of potential impacts on systems, highlighting gaps or conflicts, really gleaning those final 5 to 10% of requirements that are traditionally missed because they aren't fully defined by the customer. And ultimately, we need to focus on our end customer – the users.

We need to remember that these systems are put in place for a reason: to deliver value to end users, to improve our experience, and to make their lives easier.

Too often, issues in rail services can be traced back to poor design decisions made without sufficient support information. By taking a model-based systems engineering approach to digital transformation, we can avoid this happening in the future.

HOW CAN HARMONIC HELP?

Harmonic is leading the way in helping the rail industry respond to the challenge of digital transformation. If you would like to find out more about our work or share your thoughts on the impact of digital in rail, please **get in touch**.