Technology Adoption Case Studies

Targeted Assurance Review

11 April 2022

Contents

Acronyms and Abbreviations

CEO – Chief Executive Officer

CP6 – Control Period 6 (April 2019 to March 2024)

CP7 – Control Period 7 (April 2024 to March 2029)

DEAM – Director of Engineering and Asset Management

ELT – Executive Leadership Team

EPS – Expanded Polystyrene

GB – Great Britain

MDU – Maintenance Delivery Unit

MFBW – Mobile Flash Butt Welder

NR – Network Rail

ONR – Office for Nuclear Regulation

ORR – Office of Rail and Road

PLPR – Plain Line Pattern Recognition

PR – Periodic Review

PR23 – Periodic Review 2023 (ORR's review of Network Rail's 5-year plans for CP7)

R&D – Research and Development

TAR – Targeted Assurance Review

Definitions

Term	Definition
Developers	Refers to the Network Rail teams responsible for developing new technology until it is ready to be used on the railway. In some cases NR identifies new ideas, designs, builds and approves them internally. In other cases a product is developed by the supply chain and NR's only development role is to manage Product Acceptance.
Research and Development	In Network Rail, this is a process to assess new ideas and determine if they are technically and economically viable. The output is typically a 'proof of concept', i.e. a simple, working piece of technology which demonstrates that the idea can be turned into something real. This is used as justification for investing in further development projects, which will optimise the functionality and costs of the technology and apply for product acceptance, if needed.
New Technology	For the purposes of this report, this covers all forms of software, tools or materials, which are different from what was being used previously. This includes "innovation" (new ideas, being put into practice for the first time) but also includes technology which has been in use for some time in other industries, or other applications, but it is "new" for a particular team in Network Rail.
Technology Adoption	A process where users decide to start using new technology in their day-to-day work – either to replace old technology for the same task, or to start doing a new task which requires technology. Adoption usually starts while the technology is still in development, with the users advising the developers on technical requirements, when they need it, etc. When development is complete, developers hand over the new technology to the users, often with briefings, training, on-site trials and an opportunity for feedback. Users may have other internal processes to go through before they can start using the new technology (method statements, funding etc).
Users	Refers to the Network Rail teams who will use the new technology. This is typically regional teams who do inspections, maintenance or renewal projects on the railway.

1. Executive Summary

ORR's review found that a large number of teams across Network Rail need to work together effectively, to get new technology developed and adopted into use. We found that within each of these teams there were reasonable processes, competent people and a motivation to improve and become more efficient. However, we found significant challenges at the interfaces between these teams. Network Rail needs to improve behaviours at these interfaces, so that the organisation as a whole can realise greater benefits from the good work being done within each of the teams.

For more than a decade ORR, Network Rail and its supply chain have all recognised that the rate of adoption of new technology is too slow. In response to this, Network Rail's processes have been reviewed many times and have improved. However, we continue to see examples of technologies which make it through the development process, at significant cost, but they are not being implemented as widely as they could. Rather than review the processes again, this review selected seven case studies and examined the practical decision making and behaviours involved in moving technology from development into use.

Our review exposed some commonly held views about technology adoption, notably that "*it's normal for a lot of innovation projects to fail*", "*Network Rail is safety-driven, so it's more difficult to make changes*" and "*some people are blockers, who like doing things the old way*". We found that these are misunderstandings, which are masking the real issues.

We found recurring issues across all the case studies, including ineffective communication between different teams; team cultures which have evolved freely, rather than being led by the organisation; and failure to learn from past examples. The result is that individual teams are making decisions which appear perfectly reasonable in isolation, but these decisions often conflict with other teams' decisions. This is systematically reducing the likelihood of new technologies being adopted.

Individual teams did not recognise that a low level of adoption impacts the whole system: pushing away the supply chain; making it harder for ORR and funders to justify investment in innovation; and reinforcing the perception that "*Network Rail is not innovative*".

The issues we identified are fixable. We have produced three recommendations:

REC 1 Network Rail (through a working group or ELT) should establish a mechanism to support communication and resolve conflicts between teams of developers and users, specifically focussed on new technology.

REC 2 Network Rail (through a working group or ELT) should define a company-wide culture around technology adoption; and develop a mechanism to disseminate this effectively to all teams across Network Rail.

REC 3 Network Rail should establish a mechanism for encouraging teams to learn lessons from other teams, relating to technology projects. This could include further improvements to the way lessons are recorded and archived. But, primarily, this should focus on when and how teams read the lessons recorded by other teams.

The intent of these recommendation is for Network Rail, as an organisation, to provide more cross-team support and guidance: aiding communication between teams; establishing a shared culture between teams; and promoting learning between teams.

These recommendations cannot be achieved by any one team in Network Rail making their own processes even better. But individual teams can contribute to these recommendations, by seizing the opportunities provided by additional cross-team support.

ORR will monitor Network Rail's implementation of our recommendations over the course of our PR23 review. We will follow up 1 year after issuing this report, to capture any changes and measure any benefits or issues.

2. Introduction

2.1. Background

Network Rail's (NR's) endorsement of the Railway Technical Strategy[1] highlights that NR will need to introduce new technologies if it is going to deliver its strategic objectives; and that NR has been "too slow" to develop and adopt new technology in the past.

Every five years, ORR carries out a Periodic Review (PR) of NR's funding for the next five-year Control Period (CP). Our reviews look closely at funding for new technology. At the last review in 2018 ("PR18" for Control Period "CP6") this funding added up to more than £500 million, including £245 million for Research & Development; £190m for an 'Intelligent Infrastructure' programme; and further funding for dedicated teams to handle product acceptance, data management and procurement for new technology.

For at least the last two Periodic Reviews, NR has provided plans and justification for technology funding, which ORR has challenged and we have agreed upon improvements to processes, governance and competence. Benefits have been seen from these improvements and NR is successfully developing and adopting a wide range of new technology every year. For example, over the last three years an average of 265 products each year have achieved Product Acceptance for use on the railway.

However, in our regular monitoring of NR, ORR continues to find examples of new technology which is severely delayed, cancelled in the late stages of development, or it is delivered but users refuse to adopt it. Rather than carry out another review of the processes, this report outlines a new approach ORR has taken to gain a more holistic view of technology adoption.

2.2. Purpose & Methodology

In this Targeted Assurance Review (TAR), ORR selected seven new technologies to use as case studies (see Definitions on page 4, for our definition of "new technology"). These case studies were all identified as problematic, through ORR's regular monitoring of NR. This was not a random sample and we recognise that NR successfully delivers a large number of new technologies every year.

This review looks at a sample of technology projects, which were known to have a range of issues, so that we can better understand those issues.

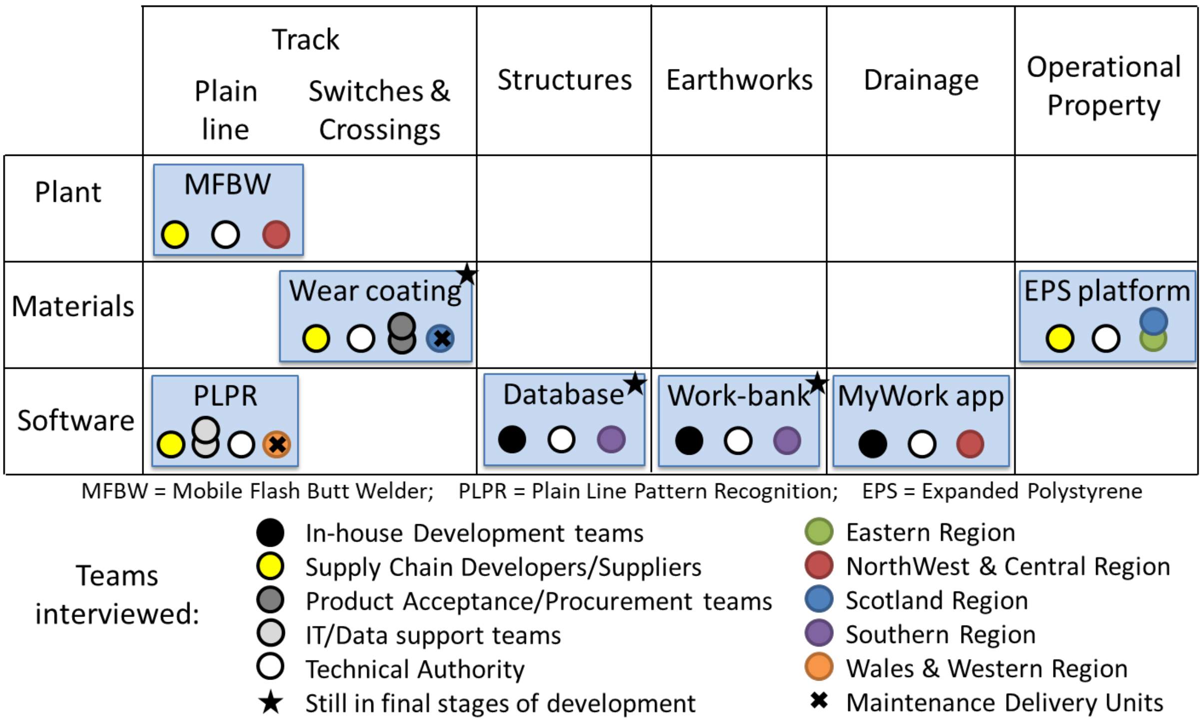
The purpose of this review is not to assess "how many of NR's technology projects have issues?". The purpose is to ask "We keep seeing technology projects with issues – why do those issues occur? And how could NR improve?".

We investigated these case studies through interviews with more than 50 people across 25 different teams in NR and the supply chain. In all of these interviews, NR staff were asked to follow up with evidence (e.g. emails, screenshots, documents etc), to support the statements they had made in the interviews.

The review focussed on the later stages of the process to bring in new technology – from finalising development of the new technology, to the users' decision whether or not to adopt it. We collected sufficient project history to understand how each case study arrived at this last step. Unlike other ORR and NR reviews, we were focussed on behaviours and decisions, rather than 'the process' of development. For example, we did not gather detailed data on project milestones, but we did try to find out who was concerned about the project milestones – and what they decided to do about it.

As shown in Figure 1, the seven case studies cover different types of technology (plant, materials and software); different asset types; all five NR regions; and they cover maintenance, capital projects and planning. We included three case studies which were still in the final stages of development. This enabled us to make first-hand observations of the relationship between developers and users, just before delivery.

Figure 1 – Technical areas and teams covered by each of the seven case studies



For case studies where new technologies came from external suppliers, this report describes them generically rather than using company or product names. ORR regulates competition in the railway industry and so, while this report seeks to increase adoption of new technology in general, this ORR report is not endorsing greater use of one particular product, over its current or future competitors.

In our interviews with NR and its supply chain, we heard many statements speculating about why people behaved the way they did. These statements gave us insights into the cultures and perceptions within NR and they helped to steer our investigation. But, before making any conclusions, we asked interviewees to provide evidence to support their statements. This evidence included emails, minutes of meetings, spreadsheets, process diagrams and internal reports.

This report presents statements we heard in interviews, because they help to explain complex issues. But it is important to note that our conclusions were based on the evidence provided – not just on the opinions of individuals we interviewed.

2.3. Structure of this report

This report identifies and explains common themes we found in this review. These themes were systemic across all seven case studies. The report presents ORR's conclusions in areas where NR is performing well; and areas where technology adoption in NR could be improved. In these areas, we have given recommendations for improvement.

Details of the seven case studies are provided in Appendix A, in the form of fact-sheets. These focus on general lessons which can be learned by future technology projects, rather than focussing on the specific technical issues faced by these technologies.

Appendix B provides examples from individual projects, which help to explain complex issues. These examples are references throughout the text, with links to the appendix. The examples are colour coded as follows:

Examples which highlight issues are presented in red boxes.

Examples which highlight good practice (from NR or other industries) are in green.

3. Findings

3.1. The seven case studies

The seven case studies are described in Appendix A and the defining characteristics of each case study are summarised below.

- Case 1 – Plain Line Pattern Recognition (PLPR): NR proposed this as an example of "successful" technology adoption. PLPR uses train-mounted cameras and image analysis software to spot defects in rails, such as cracks in the steel or missing clips. A list of defects is sent to maintenance crews to repair. This is faster, cheaper and safer than having inspectors on track, looking for defects. Everyone we spoke to in NR and ORR agreed that PLPR was innovative, technically brilliant, had undeniable benefits and had strong support at all levels within NR.

  However, the development took more than five years and the supplier explained that they had to work carefully, with a very small group of trusted NR contacts, to avoid barriers they had encountered on previous projects. The product was accepted for use in 2012 and NR has promoted its use in CP5 and CP6. But 9 years later 25% of the area where PLPR trains run has still not adopted the technology. The PLPR trains do not run everywhere, so in total less than 60% of the network is using PLPR. Given that PLPR is widely recognised as a successful innovation, this highlights how long it can take for a new technology to get adopted across the network.

- Case 2 – Expanded Polystyrene (EPS) platforms: Supporting new or extended station platforms on lightweight EPS blocks is quicker to install and requires much less heavy equipment and materials to be brought to site, compared to traditional concrete, steel or masonry structures. The lightweight EPS is also useful on poor ground conditions, where other systems may require piled foundations. NR has used EPS at 86 stations, achieving significant reductions in time, cost and risk.

  However, getting technical approval to use the product took three years, mainly because users were unfamiliar with the material and wanted assurance of its long-term performance. This was finally addressed (through lab testing, manufacturer's warrantees etc) in 2012. Adoption was very slow, taking until 2019 for four out of five NR regions to use it. The fifth region (Scotland) is still rejecting it because they remain unconvinced about the long-term performance of the EPS and, after 9 years of trying, promoters of the product have not found any mechanism to re-assure them – despite political pressure to adopt it (the material is manufactured by a Scottish company).

Like many Buildings & Civils technologies, the EPS system did not go through NR's main Product Acceptance process, because that process only covers technology directly related to train operation (e.g. track, power supply, signals etc). So developers needed to convince many different user groups of the benefits and risks before they would to approve the technology and adopt it into use – whereas for track or signalling systems they might just present a certificate to show that NR technical experts had approved it for use across the network.

- Case 3 – Mobile Flash Butt Welder (MFBW) plant: This machine drives along the track and can achieve a factory-quality weld in 40 minutes, versus 4 hours for a manual (alumino thermic) weld of lower quality. This technology has been used in other countries since the 1950's and the supply chain were providing it in GB since the 1990's. NR spent 8 years developing its own machine and procuring 10 of them.

  However, the NR developers did not clearly explain the benefits or business case to the users. Some users thought MFBW was intended to improve the quality of welding, but the failure rates from manual welding had reduced significantly over the 8 years, so they no longer saw the benefit of MFBW. Some users agreed to trial the MFBW, but it broke down regularly, so they lost interest. Some users tried to book the MFBW for maintenance work, but because the machines were shared nationally, it was not worth the effort to try and book them for small jobs. Some MFBW's were used initially, but usage quickly dropped off.

  There may still be a good business case for using MFBW on track renewal projects, because of the significant time saving relative to manual welds. But users are not clear whether the MFBW is still available, or if they are allowed to procure MFBW through the supply chain. In fact, NR is in the process of selling all 10 MFBW units to another country. NR is currently developing a new welding machine (the Induction Welder) with many similarities to the MFBW – and again the developers have not clearly explained the benefits or business case to the users.

- Case 4 – 'My Work App' on-site recording application: This app runs on a mobile phone or tablet and allows NR users to log information on site, such as recording the condition of drainage assets during inspections, or recording how much fencing was replaced during a work shift. The app connects straight to NR's asset database, removing the need for paper records or data entry when staff get back to the office.

  This was one of many tools developed as part of a large NR innovation programme in CP5 ("ORBIS"). The tool was delivered and a small, core group of users attended training, but shortly afterwards the ORBIS team disbanded. There was a lot of negative feedback from users, mainly because the interface was hard to navigate and there was no map to confirm if they were looking at the correct assets on site – but there was no development team left to address these issues.

One out of the five NR regions (Northwest & Central, known at the time as London North Western route) rejected this app altogether and procured a different tool with a better interface. But their tool does not connect to NR's database, creating a major data handling challenge which continues to cause problems today. In the other four regions, NR's central Technical Authority were left to train more than 1300 staff around the country, to deal with their negative feedback and to try and find ways to edit the app software to improve it – a task they are not trained or resourced to do. Now, 6 years later, NR is developing a new tool to perform the same task (and some additional tasks), with an interface which meets the users' needs.

- Case 5 – Wear coating for switch rails: This is a tungsten carbide coating, applied to normal rails in the factory, which prevents the sides of the rails wearing down as train wheels rub against them. The main issue with side-wear occurs where trains are changing direction at switches (junctions). This is such a high priority for NR that it has issued public 'Challenge Statements' inviting the supply chain, universities or anyone else to propose solutions. This product is widely used in other industries, e.g. oil & gas and manufacturing.

  NR began trialling the product at one site. The team running the trial were technical experts, but had no specialist training or guidance on how to plan and run a research trial. After one year of trials, there was no clear outcome, so the trial was extended. Five years later, the trial had been extended for a fifth time and covered six sites, but there was still no clear measure of whether the product passed or failed the trial – or what value the product could provide users. Under pressure to resolve this, NR recently withdrew the trial and did not approve the product. But users are still urgently looking for technology to prevent side-wear, they are not clear of the status of the trial and some are contacting the supplier directly to try and find an alternative way to get the product approved for use.

- Case 6 – Earthworks work-bank management tool: In 2011, users requested a software tool to help them manage their work-bank. This is a list of hundreds of projects to be delivered over a five year period. The work-bank is constantly evolving as more information comes in from site and priorities change due to bad weather and funding issues. The users built a mock-up (or 'proof of concept') in Excel. NR decided to develop this as part of a much larger tool ("CSAMS"), which aimed to bring together all the data about all their civil engineering assets. After 6 years, the CSAMS project realised this goal was not deliverable – and the project descended into a commercial dispute, without delivering any of the tools.

The users have had to sub-optimally plan and manage two whole Control Periods (CP5 and CP6) using the Excel mock-up. In 2019 another large innovation programme ("Intelligent Infrastructure", or "II") committed to delivering a number of tools – including this work-bank tool. For the next two years, users and developers met regularly to discuss progress, but still no tools were delivered and users had lost trust in the developers, assuming that CP7 would also have to be planned using the Excel mock-up. As part of this review, ORR interviewed users and developers and we were able to pin down the users' exact deadlines and needs – and II were able to deliver an interim tool for use in CP7 planning, barely in time to meet the deadline.

- Case 7 – Structures consolidated database tool: In 2011, users requested a tool which brought together more than a dozen separate databases – for example, to decide what work to do at a bridge, NR engineers needed to look at one database to see the condition of the structure, a separate database to see scour risk from the river it crossed, another for traffic loading over the bridge, and so on. This became part of the CSAMS project and the history is exactly the same as Case 6 above.

  The key difference between Case 6 and this structures tool is that the II programme have now delivered 1 out of 13 components of the final structures toolkit and users did not seem to have lost trust in the developers. The concern now is that users and developers are saying "we won't see the full benefit of these tools until we complete all 13" and there is a risk of repeating the same mistakes as CSAMS – aiming for a single tool, which is too big to deliver.

The following sections explain systemic issues which we found across all seven case studies.

3.2. Common misconceptions

During our interviews, there were four statements made repeatedly, as an attempt to explain why new technology is not adopted in NR. It is important to understand these before discussing our other findings.

- "There is always uncertainty in innovation – you have to try lots of different things because you know some ideas won't work out"

  This is a misunderstanding. This statement is true for "Research" (or what NR defines as R&D) which involves exploring new, plausible ideas and trying to prove whether they will work in practice. The answer for some ideas will be "no". However the problem we are trying to understand is not about R&D or 'ideas'. In this review we are looking at <u>technology adoption.</u> These are technologies where NR has already determined that the technology works and that it has a business case. For these technologies NR has already invested several years and large sums of money into fine-tuning the technology and making sure it complies with technical and safety standards. In all of our case studies similar technologies have been used, successfully, in other industries for several decades.

When these technologies are presented to the users, there should be no uncertainty about whether the products work and whether they provide value for NR. If there is any ‘uncertainty’ about whether users are going to adopt technology or not, this indicates that either the developers have not engaged successfully with the users during development – or the users do not know how and why to adopt new technology.

- “NR is devolved into regions. It is perfectly reasonable for some regions (or local delivery units) to adopt a new technology, while others reject it – because they face different challenges. So, NR would never expect 100% adoption.”

  Technically, this statement is true. ORR appreciates that the benefits of new technologies will not apply equally to all regions or MDUs, so we are not expecting to see 100% adoption of new technologies. However, it is important to clarify that in all the case studies in this review, we found that technology was being rejected for a wide range of reasons – not just because of different local challenges. Many of these reasons were avoidable (e.g. teams making decisions based on incomplete information; or due to a lack of technical support). The assumption that a low level of adoption is acceptable, because it just reflects local differences, is inaccurate and misleading.

- “NR is safety-focussed – so it is risk averse – so it isn’t innovative"

  This is another misunderstanding – and the wording tells us a lot about people's attitudes to and understanding of risk. If NR is developing new technologies in line with best practice, then we would expect the new technology to reduce safety risks relative to the old technology, either directly through safer work practices, or indirectly by reducing the number of asset failures. Consequently a safety-focussed, risk averse organisation should be adopting more new, proven technology, not less.

  There is often some uncertainty around new technology and this may be harder to visualise and quantify. This uncertainty may be perceived as a greater risk than the familiar safety risks of the old technology. In all of our seven case studies, this uncertainty should have been reduced to negligible levels through the product acceptance process, trials, user training – and the fact that all these technologies have been used successfully outside of NR. Unfortunately the case studies showed a lot of user uncertainty, for reasons discussed later.

- "There are some people who are 'blockers' – who like doing things the way they've always done them – and they resist change".

  We did not find any evidence of this in our review. All of the NR staff we interviewed demonstrated that they are not satisfied with the way things are done now and that they are comfortable challenging existing methods. They appeared eager to make changes and they wanted to be associated with projects which bring in new technology. However, they all expressed significant frustration about how hard it is to develop and adopt new technology in NR, to the point that they may end up rejecting (or 'blocking') new technology because it was simply too difficult.

3.3. Silo thinking

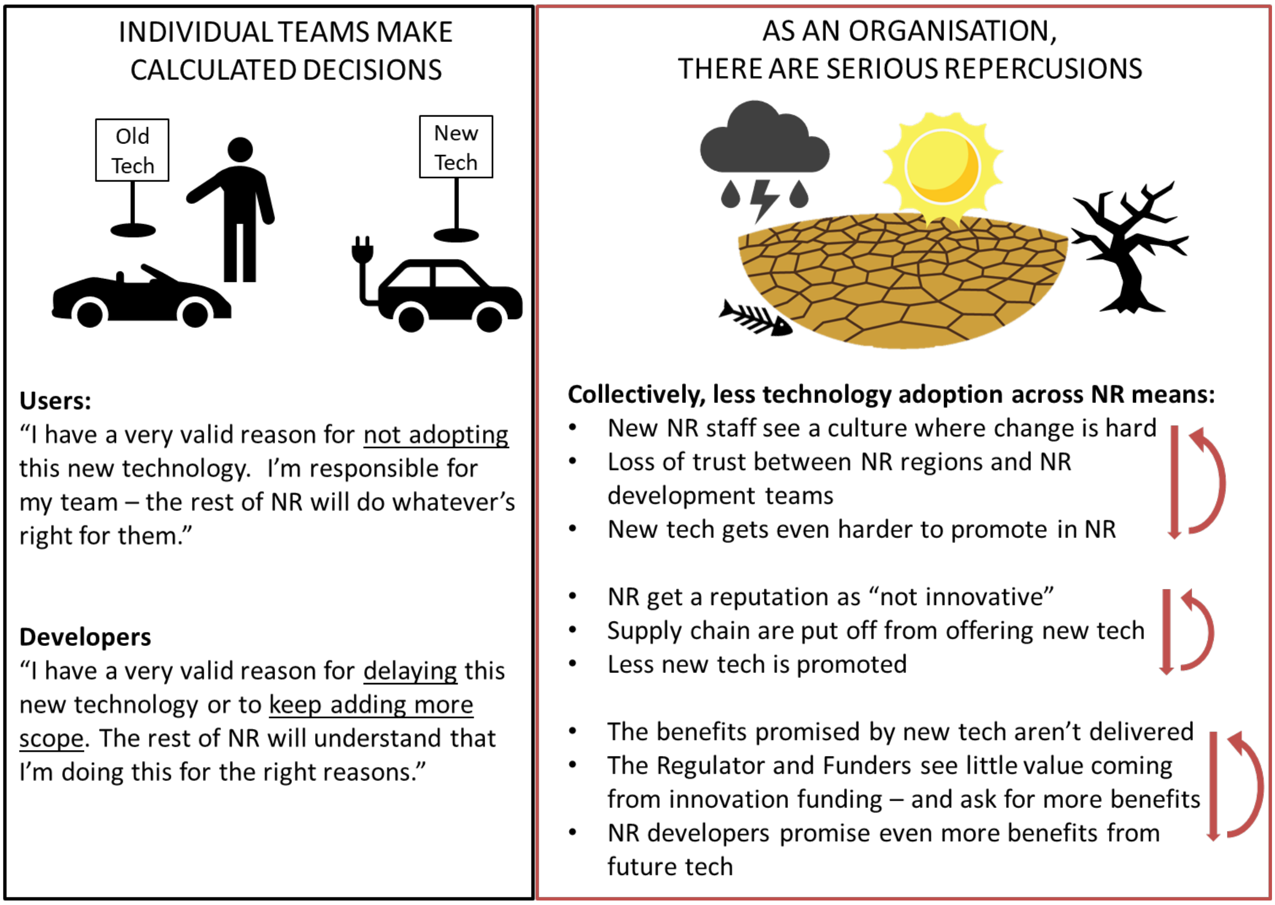
We found that every team we interviewed had a very clear justification for their decisions. When we were presented with the information they had available at the time, their decisions did not just seem reasonable – in most cases they were the obvious decision and any other decision would have been questionable. This presented a problem, because the developers appeared to be making the right decisions with the technology – but the users also appeared to be making the right decision by not adopting it. The root cause of this problem was that, in every case, the two teams were looking at two different sets of information.

We refer to this as "silo thinking", where two or more teams are making decisions within their own area, independently from each other, even though they are trying to solve the same problem. Staff across NR are receiving large amounts of information every day, including their day-to-day work but also emails about new products, training courses, and company updates. This volume of information increases the chance of one team missing key information, which another teams see as a priority; and for teams to react differently to new information.

This presents an obvious problem for technology adoption, that developers can produce the right product at the right time and yet the users can still refuse to adopt it because they are basing their decisions on different information. This is discussed in the next section. But there is a greater, less obvious hazard from silo thinking. All of the teams we interviewed complained about how hard it is to develop and implement new technology, but none saw the connection between the decisions they are making in their teams and the repercussions at the organisational level. These repercussions are outlined in Figure 2.

The key message is that low levels of adoption create an environment where it becomes even harder to develop and adopt new technology in the future. This is not sustainable – and it is made even worse by the fact that there is little or no awareness of this effect among NR teams.

Figure 2 – The repercussions of decisions made by individual teams, on the environment for the whole organisation



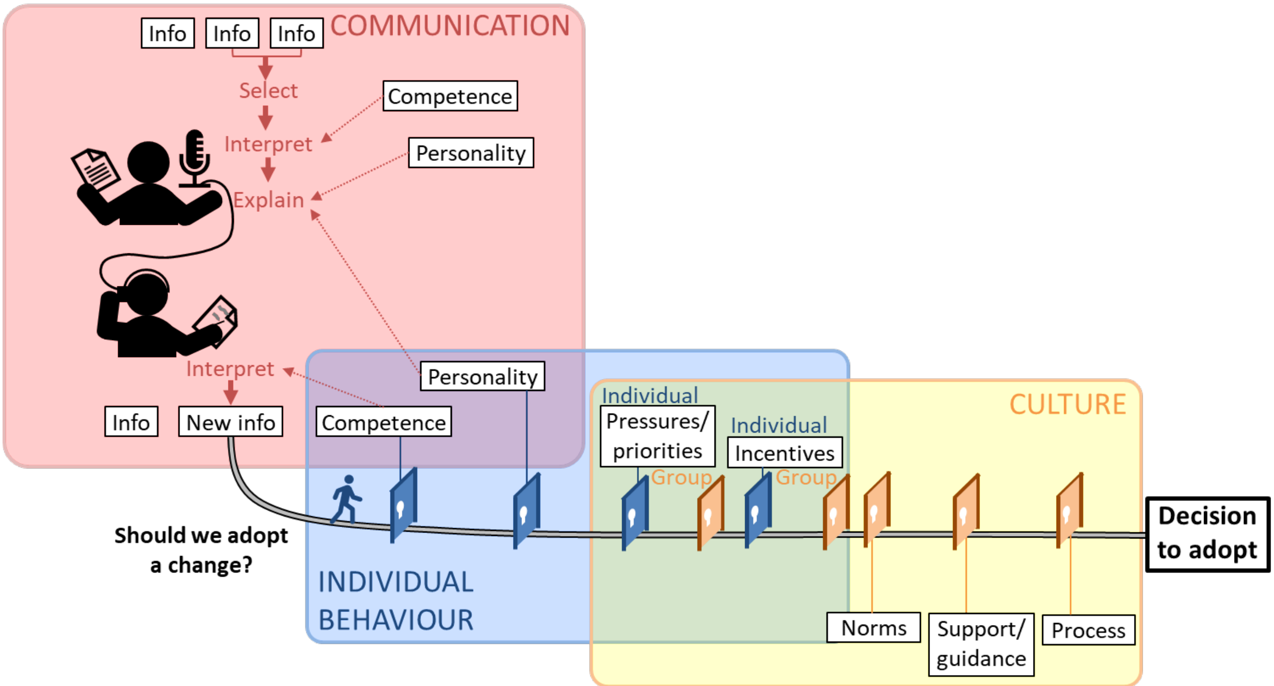
3.4. The decision pathway

As noted in Section 3.3, we identified a major issue around individual teams making contradictory decisions because they were looking at different information. So, we used the evidence we collected from the seven case studies to develop a simple process map for how NR teams convert information into a decision to adopt changes. This is presented graphically in Figure 3 and the key aspects are outlined below, along with examples from teams we interviewed.

Communication

Figure 3 begins with one team communicating an idea or a product to another team. We found that this communication was often described as a one-way transmission of information. Developers and users held regular 'engagement' meetings together and everyone was free to talk and ask questions. But key transfers of information were often through a technical presentation or detailed email, giving a proposal and checking for any objections, rather than a collaborative discussion to unpick each other's information and agree a shared set of priorities, risks, and opportunities. [Example 1]

Figure 3 – The pathway from information held by one team, through to another team deciding to adopt a change.



The lower part of figure 3 shows the decision-making process, once a team receives new information. We have shown this as a series of locked doors or barriers, which all need to passed for the technology to get adopted. Each barrier could trigger the team to reject the new technology – or at least make the process longer and more arduous. This image is based on recurring phrases we encountered throughout our review, including "obstacles", "obstructions", "barriers" and "blockers".

Competence and Personality

All of the people we interviewed in this review demonstrated a reasonable level of competence and professionalism. However, when individuals or teams work together there can be differences in competence, or conflicts of personality. We found examples where communication and decisions were affected by personality types and competence. These were not the main reason for a decision to reject the technology, but they clearly had a negative impact on how users interpreted which was being presented to them. [Example 2]

Pressures, Priorities and Incentives

These represent the other work activities which decision makers need to weigh against the adoption of new technology. Individual factors might include having a backlog of work so they are too busy to attend training courses, bonus schemes and promotion opportunities, or what triggers good or bad feedback from their managers. Group factors might include budgets, KPIs or current regional priorities.

We also found examples where short-term priorities were driving the decision not to adopt technology [Example 3]. But these short-term priorities are constantly changing, so the timing of the decision around technology adoption is very important. [Example 4]

Norms

These are the precedents and common practices which develop in any group. If a user analyses all the available information and comes to a decision, but this decision differs from what the rest of the group are doing, they will naturally tend to re-evaluate their decision. Most of the user teams we interviewed gave more examples of new technologies which had been rejected or ran into problems, than successful adoptions. So, it could easily become the norm in these teams, not to adopt new technology. [Example 5]

Support/guidance

This includes NR's formal guidance documents, standards and briefing materials produced by developers. It also includes subject matter experts who users can contact, or software tools provided by NR to support users. In several of our case studies we found an absence of support, or we found guidance materials which actually interfered with the decision making process. In particular, we found guidance documents which do not promote objective, fact based decisions – instead they leave users to make subjective decisions, based on their own interpretation of the text. This means that two teams can make conflicting decisions based on the same guidance. [Example 6, Example 7]

Process

This refers to both the process of bringing in the new technology (e.g. procuring the equipment, training staff, planning when and where to use it etc) and also local change control processes to stop using the old technology (e.g. updating health & safety risk assessments to reflect a different method of working). Our review found that most users saw these processes as a major barrier to adopting new technology. The process to stop using the old technology can be as important as the process to develop new technology – but development teams do not appear to be supporting users with this. [Example 8]

NR has a detailed 'Product Acceptance' process and a dedicated team to oversee this, but this only covers technology directly impacting the running of trains (e.g. track, power supply, signals etc). In our review, NR's Buildings & Civils teams highlighted that the technologies they use on buildings, structures and earthworks mostly fall outside of the main Product Acceptance process. Working outside of NR's central process increases the risk of teams having to develop their own processes, making decisions in isolation, or struggling to develop and adopt technology without any support or guidance.

Similarly, software is not covered by the Product Acceptance process. NR's Intelligent Infrastructure and Route Services IT teams have developed their own detailed processes for development of new software, which are robust and well documented. However, this presents yet another process which is new to most users and which they may perceive as a barrier to adoption.

There is an important question around "who is the person in Figure 3, passing through all these barriers?". Typically this will be the 'project sponsor'. A successful sponsor will need to understand all of the processes, incentives and cultures of the different teams involved. For large construction projects, NR has a community of dedicated sponsors, who are specially trained to understand all the commercial, technical and managerial aspects of a project. There is no such sponsorship community for new technology projects.

For the software-related case studies, the Technical Authority were usually named as sponsors, but the practical duties of sponsorship (securing funding, choosing delivery options, prioritising deliverables) was typically performed by a manager from the developer team. Some of these individuals had experience of being on the user's side, but on these projects their pressures, their cultures and the processes they were following were developer-focussed. Developers would also cease sponsoring the project shortly after handing the technology over to the users – while the technology was still in the early stages of adoption.

For the other case studies (new plant or materials) the sponsorship role was even less clear. The sponsor was typically from the Technical Authority – a nominated technical expert, with no requirement for training or experience in sponsoring a technology project. The barriers in Figure 3 are an issue even within one team, but they become even more challenging when the sponsor is working outside of their own team, or if there is no clear sponsor for the latter part of the project (adoption by users).

Figure 3 presented a high-level view of the barriers which could prevent a team from adopting new technology. The following sections explain some specific issues we found in our review, at a more detailed level.

3.5. The language barrier

We found that all development projects had engaged regularly with users, including NR's central experts from the Technical Authority and representatives from all regions. In some cases, development teams had been sent on training courses to improve their understanding of engineering, or other technical specialisms, with the assumption that this would help them communicate better with the users. However, we found that none of this was a guarantee that developers and users would leave the engagement meetings with the same interpretation of what had been discussed.

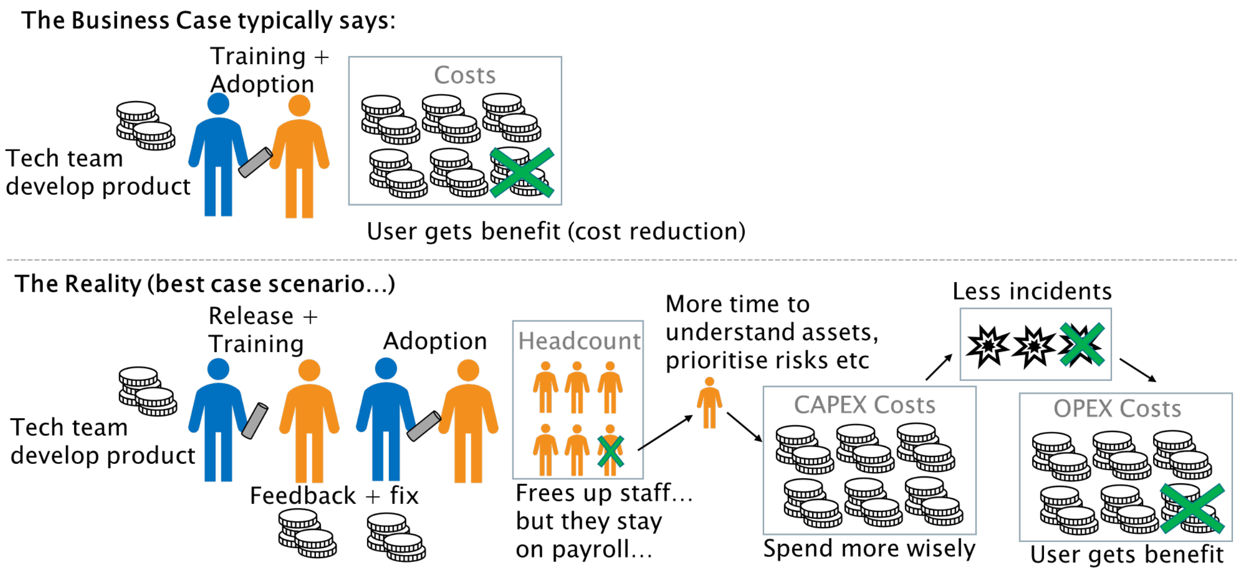
In all of our case studies, both the developers and the users expressed a high level of frustration with the other, often blaming each other for delays and rework because they were “moving the goal posts” or not providing clear information. On the basis that this issue was systemic across all of our case studies, there appears to be a fundamental language barrier between developers and users, which can only be overcome with organisation-level support. [Example 9]

3.6. The benefits chain

When ORR reviews funding for innovation at five-yearly Periodic Reviews, NR typically justifies its funding using benefit:cost ratios. This implies that the new technology will deliver a benefit in terms of a cost saving, which is greater than the amount spent on development. When technology is not adopted, clearly the benefits are not delivered. But, even when new technology is adopted, it is usually very difficult to measure any cost saving immediately. Often there will be cost increases associated with training and procuring the new technology, or continuing to run the old technology as well until the new technology is proven to be effective. We found that users often struggled to understand or quantify the savings they expect from new technology, which makes it very difficult for them to justify the up-front costs to adopt the technology.

Our case studies showed that the benefits of adopting new technology often take several steps before any cost saving is reached, but in the long term the benefits are very valuable. This is shown graphically in Figure 4. The upper line represents a simple business case, where delivering the new technology immediately cuts costs. In the lower line, the technology does not create an immediate saving, but there is an immediate benefit – that staff are freed up to focus on something else. Several steps along the chain, this is likely to turn into a cost saving, for example this extra resource might allow NR to spot issues proactively before expensive failures occur; have more time to optimise plans; or identify more opportunities for new technology. NR and ORR need to understand this benefit chain, to ensure we are not discouraging adoption of new technologies which require many steps before they deliver financial benefits. [Example 10, Example 11]

Figure 4 – Comparing simple business cases assumed in early development, against the actual benefit chain



3.7. Condensed decisions ("take it or leave it")

Figure 3 showed the pathway to a decision and the barriers. Our review found that NR's processes around technology adoption systematically condense the time period over which users have to make this decision. This makes it less likely that users will reach a decision to adopt. The main issues are:

- Once development is complete, the development team are incentivised to close out their project as quickly as possible and start delivering their next project. [Example 12]

- Several case studies noted that users agreed to trial products in their areas, but this would typically be a single trial and if any problems arose then they were unlikely to adopt the technology – condensing the decision down to a single data point. New technologies are likely to experience 'teething problems' when first used, so basing a decision on a single trial will significantly reduce the chances of new technology being adopted. As noted in Section 3.4, most users and developers in NR do not have any formal training in conducting scientific trials. Any support or guidance on best practice would show that at least three trials are needed to come to a scientific conclusion about how the technology is performing. [Example 13]

- Section 3.4 above raised the issue of guidance documents which allow users to make subjective decisions based on their interpretation, rather than using objective analysis. Subjective decisions are often made quickly and people are less likely to revisit subjective decisions and change their mind, as this would imply their judgement was wrong. If a decision was based on clear analysis, if new information came to light then it would be easy to revisit the analysis and the user would have a clear justification for changing their position. [Example 14]

- When NR development teams produce new technology, these are always 'optional' for the users. Several teams in the Technical Authority noted that they want to encourage greater adoption of particular technologies to help NR meet its strategic goals (e.g. carbon neutral targets), but they do not have any effective mechanisms to do so. Technical Authority produce policy documents and standards which the regions must comply with, but these do not mandate the use of one particular product. The policies and standards can try to discourage the use of old technologies by adding new criteria.

  We presented an example earlier where a new environmental standard and guidance note were intended to encourage the regions away from concrete and steel based designs to more sustainable materials, but these were not prescriptive and regions could interpret them to suit their own decisions. We found several examples like this, where central functions had tried to drive adoption through standards, but were unsuccessful. [Example 15]

  In 2019 NR formally devolved into five regions and the organisation is still adjusting to the change. There are ongoing discussions about the level of autonomy of the regions and in particular the regions are questioning whether they have the authority to approve new technologies to meet their own needs, rather than technology being developed and approved nationally. If the regions become more autonomous around product acceptance and standards, then central development teams and the Technical Authority will have even less power to encourage greater technology adoption. In that case NR will need to ensure that all the regions are taking responsibility for encouraging greater technology adoption within their region. This is discussed in Section 4.1.5.

3.8. Lessons documented – but not learned

Many of the teams we interviewed mentioned that they had 'learned lessons' during this technology project, or from previous projects. However, we found two issues with this:

- These lessons were typically not being shared with an audience outside of the project team, so there was no 'learning' in the sense of people hearing about this for the first time.

- Even within the project, we found several instances where the same problematic decisions were being repeated over and over again, indicating that teams were not ‘learning’. [Example 16, Example 17, Example 18]

These are cases where the projects carried out a formal ‘lessons learned’ review. But we also found numerous examples where there was no detailed review – and even some examples where there was little or no attempt to collect any feedback from the users. [Example 19]

4. Conclusions and Recommendations

4.1. Conclusions

4.1.1. The high-level issue

For most industrial technology outside of the railway, the developers and the users are both private companies, driven by profit motives – and between them is a whole ecosystem of market research, advertising and sales.

NR's developers and users are both managed within the same organisation and it might be assumed that both are working together towards common goals. However, due to the sheer volume of information being produced, the broad range of technical specialisms and NR's approach to delegating responsibility across the organisational structure, it is not valid to assume that teams share the same information, drivers, or measures of success.

When the developers and users are not working with the same information and goals, the burden of market research, advertising and sales falls to the developers and the users. These people are neither trained nor resourced to perform these roles. There are many positive examples of new technologies being adopted in NR, but these examples are accompanied by stories of 'heroism', of individuals going beyond the call of duty to overcome obstacles and convince stakeholders through sheer force of will – or stories of 'luck', of developers who happened to have close friends in the user team, or users who happened to know about the technology from another application. All examples of technology adoption come with stories of immense frustration on all sides and a feeling that change should not be this hard. [Example 20, Example 21]

4.1.2. What is missing?

All of the NR staff we interviewed expressed a desire to be innovative and to find efficiencies wherever they could within their area of NR. Without exception, they demonstrated a good level of competence in their specialist area and they could provide good justifications for all the decisions they make within their area – including decisions not to adopt new technology.

But, as soon as we zoom out from individual teams and look at NR as a whole, it becomes obvious that the decisions made by different NR teams are conflicting with each other. [Example 22]

Each part of NR is trying so hard to be innovative and efficient, that it has a detrimental effect on the innovation and efficiency of NR as a whole. Increasing technology adoption will require teams to work together better – as opposed to each of the teams trying to become even better at the tasks within their control.

In Figure 3 we saw that the three elements of the decision to adopt were Communication, Individual Behaviour and Culture. The conclusion from our review is that the Individual Behaviours within all NR teams were reasonable – individuals were competent within their normal subject areas, professional, self-motivated to be innovative and were prioritising improvements in network-critical areas. But, we have also reached the conclusion that the inter-team elements of Communication and Culture are not being managed effectively.

- **Communication:** NR teams are expending a lot of resources 'engaging' with other teams and NR's processes mandate this engagement. But having lots of engagement meetings is no guarantee that the key messages are actually getting across and being understood. Our case studies highlighted numerous examples of engagement missing the key issues and there was an overwhelming sense of frustration on all sides that "they are not really listening to us".

  Good communication is not just the responsibility of the teams and individuals involved. NR as an organisation has a responsibility to provide guidance, tools and specialist support to facilitate good communication. Central support and guidance needs to consider that not all technologies go through NR's main Product Acceptance processes – in particular, software and many Buildings & Civils activities are not covered. [Example 23, Example 24]

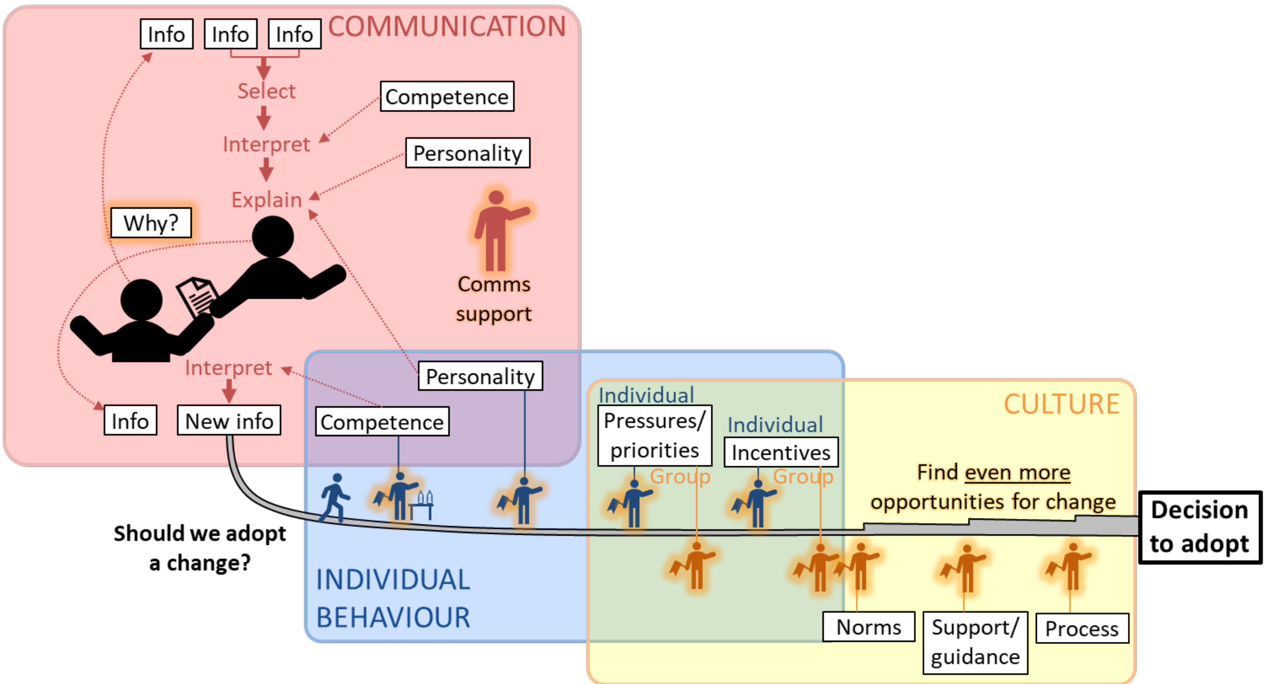
- **Culture:** All the references to "culture" in our interviews were negative, either suggesting that "NR does not have an innovative culture", that "more innovation will require NR to make a cultural change" or that "NR's culture actively stifles innovation".

  Actually, the conclusion from our review is that there is no clear "NR culture" around innovation – or if there is, it is not visible in teams involved in technology adoption. There were obvious cultures within different regions, different asset types, or in development teams. These team cultures appear to have developed organically, based on historical bad experiences, a few dominant characters in influential positions, or staff progression routes (e.g. managers who started out on maintenance crews, versus managers from an office background). These local cultures were not clearly documented or controlled, with one exception [Example 25].

New technology projects typically cross multiple regions and technical teams, the development takes several years and the adoption process can span whole generations of NR staff. So, allowing cultures to form locally and evolve over time, increases the risk of teams making conflicting decisions, which prevents the adoption of new technology. Our conclusion is that NR as an organisation should be defining a clear and consistent culture around innovation and technology adoption. [Example 26]

Figure 5 shows an improved version of the decision pathway, where Communication is more interactive and has specialist support. Now all the 'barriers' have been replaced with 'supporters', not just opening up the pathway but actively pushing the decision towards adoption of new technology.

Figure 5 – An improved pathway, with collaborative communication and support for new technology at every step



4.1.3. Why solving these issues is challenging

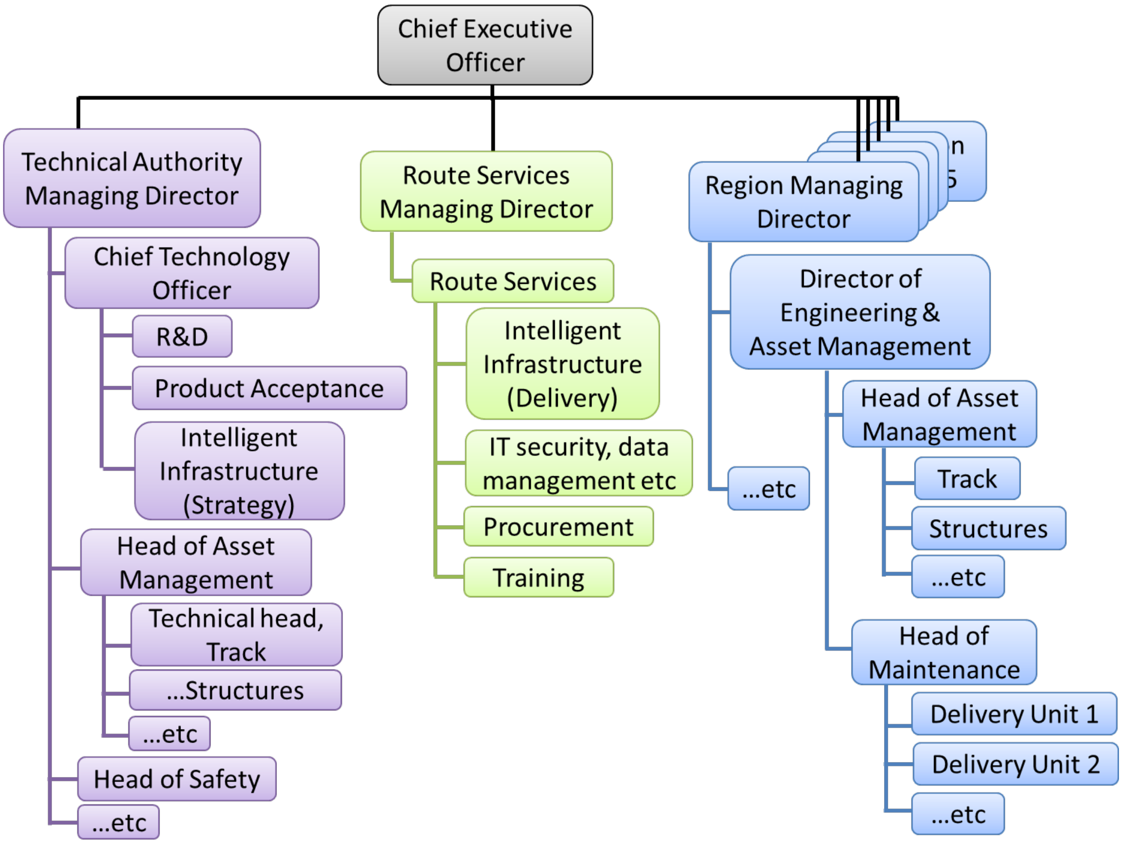
There are two main challenges around improving Communication and Culture in relation to technology in NR:

- The users of the next technology project might be anyone in NR, from local maintenance teams, to regional planners, to national technical experts. As a result, NR cannot simply add steps to the process for one particular team, or send a few teams on a training course – changes will need to impact a large portion of NR's

42,000 employees. So, any changes need to be simple enough to communicate to a large number of people, with a broad range of interests and backgrounds, while still being robust enough to deal with complex technology issues. [Example 27]

- Figure 6 shows a simplified version of NR's organisation chart. Within each coloured column there are several levels of managers, Heads-of and Directors. This allows problems to be escalated and dealt with effectively. For example, if maintenance delivery units 1 and 2 (bottom of the blue strip) were making decisions which conflicted with each other, this would be escalated to the Head of Maintenance to resolve. If they could not resolve it, it could be escalated to their Director, and so on. If the R&D team's decisions conflicted with the Product Acceptance team (middle of the purple strip), they could escalate this to the Chief Technology Officer to resolve.

Figure 6 – A simplified Network Rail Organisation Chart, showing the most common developer and user teams



However, if there are conflicting decisions between a team in one column and a team in a different column, then this issue would need to be escalated right up to the Chief Executive Officer to resolve. The issues would have to be monumental for the teams to try and escalate it to the CEO – and they would need to convince all their internal Heads-of and Directors to escalate the bad news (something they may be unwilling to do, especially if they think another group should be dealing with this). [Example 28]

4.1.4. Learning lessons

One important conclusion from this review is that using case studies has provided a very different picture from previous reviews, which looked at processes, documentation, cost benefit ratios etc. By their nature, new technology projects all introduce new technical challenges and new interactions between small, specialist teams across NR. As a result, every project has a unique and interesting story to share – which no-one could ever learn by reading guidance notes or process standards. Because every project is so different, most of the information about one project will be irrelevant to the majority of people – and if it becomes relevant in the future, they will have no way of knowing that this project happened and that they need to learn about it.

All the senior NR managers we interviewed made it clear that 'lessons learned' reports are important to them and that they put significant effort into capturing lessons learned at the end of projects and sharing these lessons with anyone who they think will find it relevant. There are two fundamental issues with this approach:

(1) All of the NR lessons learned reports we have seen are extremely detailed. They are written in terms of "*if the same team did a similar project again in the future, here's exactly what we would do differently*". The amount of detail creates an additional exercise, for readers to spend a long time digesting all the information, figuring out if there are similarities with their project, then coming up with their own interpretation of how to apply recommendations to a slightly different situation. [Example 29]

We have seen in this review that, although our case studies were very different, there were common themes which a lot of people would recognise in their own projects (e.g. silo thinking, cultural norms etc). Some projects provide really clear examples of these issues – and these examples are much easier for people to understand than reading a generalised, 'text-book' explanation of the issue. There may also be examples of unusual cases, which are not covered in the 'text-book'.

Providing a short summary of transferable lessons might provide more benefit than a detailed, technical report. This could be 'as-well-as' a detailed report, as the details may be required for project-specific forensic reviews, contractual claims etc.

(2) The responsibility is put on the team writing the lessons learned report to determine who needs to read it. They will not be aware of all the other projects going on across NR so they may not identify all the right people. Furthermore, this is a one-time exercise and if a new project starts several

years later, that team are typically reliant on word-of-mouth to find out about similar projects in the past (there is a common conversation at all types of project reviews, along the lines of "*we had a similar issue on the __ project. You should speak to __ and try to get hold of their report*"). NR could get more benefit from lessons learned reports if there was a better system for flagging which future projects need to read the reports. [Example 30]

Our conclusion is that most NR teams have a system for recording 'lessons learned' reports and storing them so they could be read again in the future. But, these systems are not being widely utilised. Future projects are not likely to read these reports and, if they do, they have to read through a lot of specific details and may miss the fundamental issues.

Lessons learned reports might attract more readers and deliver more benefits, if they focussed less on technical details and more on "storytelling" – providing real examples of people overcoming problems, which the reader can relate to their own work. For example, we hope that readers of this report will find the many, short examples in Appendix B easier to digest, than if we gave a detailed forensic account of one project.

4.1.5. Improvements by Network Rail

It is important to note that four of our case studies were approved for use more than five years ago. In that time NR has been through at least one Periodic Review and has made numerous changes to try and increase technology adoption. These changes may address some of the issues seen in our case studies. Most of these changes made by NR appear to focus on processes, rather than the communication and culture issues addressed in this report. The most positive examples are outlined in [Example 31, Example 32, Example 33].

Since the last Periodic Review (in 2018) NR has devolved its business into five semi-autonomous, geographical regions. Previously the regions were more reliant on NR's central technical experts, for policies and guidance on adopting new technology. Now the devolved regions have greater flexibility to prioritise which new technologies they will take an interest in. For items such as software and off-track technologies which do not require NR Product Acceptance, the regions have even more flexibility to develop and procure technology within the region, rather than going through the centre.

Devolution is relatively recent and NR's regional organisation charts, processes and accountabilities for new technology are still evolving. None of the case studies in this review was entirely ‘post-devolution’, but our interviews and the evidence NR provided for this review highlighted some immediate impacts of devolution:

(1) The devolved regions have stronger incentives to meet their own targets and solve local problems. Where regions have identified new technology projects which align to their current needs, they are actively seeking to accelerate development, for example by nominating one of their own users to sponsor the project through development and into adoption. Previously the sponsor was typically from the central Technical Authority, or from the developers’ side. Regional sponsorship is likely to have a positive impact on adoption, because the sponsor takes responsibility for communicating the users’ needs clearly to the developers. Then the sponsor can help to communicate the business case and technical details from the developers back to the users. Within the sponsoring region there will be a sense of ownership of the new technology; and users stated that having a regional sponsor (even if it was not from their own region) reassured them that users were driving the project rather than developers, which helped to increase adoption.

(2) Opinions about their role in approving new technology varied between regions and asset types. For example, track maintenance engineers in Scotland stated that they still rely on NR’s central Technical Authority to advise them when new technologies have been approved and under what circumstances they should use them. However buildings engineers, also in Scotland, believed that they were now fully autonomous in terms of approving new technologies and no longer relied on the central Technical Authority. NR’s Network Technical Head of System Compatibility clarified that roles and powers around Product Acceptance are still in discussion between the regions and the centre, following devolution. Contrary to point 1 above (where regions ‘sponsor’ a project), if regions develop new technologies entirely independently from each other, we would expect to see a negative impact on adoption. This is because we found cultural barriers to adopting products which users feel ‘someone external is forcing on them’, or where users were not involved enough in the development to understand the benefits and business case.

(3) NR demonstrated that there is some ‘horizontal integration’ between regions. For example each asset type has ‘Asset Technical Review’ meetings every four weeks, to share technical issues and solutions. However, issues around funding or priorities are typically escalated ‘vertically’ within the region and would not be discussed with other regions

unless there was a serious issue (serious enough to escalate right up to regional directors).

4.1.6. Why now

Example 34 describes a critical point in time, when the nuclear industry identified they could not deliver one of their key priorities unless they could find ways to accelerate technology adoption. Improvements have now been achieved, by addressing interface issues between the parties involved.

NR is managing the oldest railway network in the world and one of the busiest, amidst the economic and environmental impacts of a global pandemic and a growing climate emergency. The case studies in this review show that there can be a time lag of 5 to 10 years between identifying a new technology, developing it and getting it adopted by users.

If the railway network is going to respond to climate change and other challenges proactively, rather than reactively, then we have reached a critical point in time when the rate of adoption of new technology needs to accelerate. For this to happen, issues at the interfaces between teams need to be addressed urgently.

4.2. ORR's recommendations

This review concluded that individuals and teams working within NR have consistently demonstrated reasonable processes, technical competence and a determination to innovate. However, NR as an organisation does not have enough cross-team support to ensure that technology is developed and adopted efficiently and in line with best practice. We recommend that NR improves its support in three key areas: communication, shared culture and learning lessons.

Based on our findings and conclusions, ORR has three recommendations to improve technology adoption, by better supporting communication, culture and lessons learned at the organisation level. These issues are complex and it is difficult to predict what outcomes a change might have. Our recommendations define the three areas with the greatest opportunities for improvements and we have indicated the outcomes we expect to see. NR will need to determine the details of changes it can make, to achieve these recommendations.

It is important to note that none of our recommendations can be achieved by a single team within NR – as they all relate to the interfaces between teams.

Individual NR teams reading this report can contribute to the success of these recommendations, not by tightening the processes within their control even further, but by striving to treat other teams as a help, not an obstacle.

These recommendations will need to be implemented by an NR working group with the authority to instruct changes across all parts of NR. NR has suggested that they could either use an existing Director-level working group, which covers all regions and central functions, or they could establish a new working group. If NR cannot determine a suitable working group, then ORR will expect NR's Executive Leadership Team (ELT) to take ownership of these recommendations.

For all three recommendations we expect NR's working group (or ELT) to provide written evidence during our PR23 review, outlining any new mechanisms, roles or processes. ORR will contact a sample of technology projects 1 year after issuing this report (during our PR23 review), to look for changes and to collect evidence of any benefits or negative impacts. The outcomes we expect to see are outlined beneath each recommendation.

REC 1 NR should establish a mechanism to support communication and resolve conflicts between teams of developers and users, specifically focussed on new technology. This mechanism should be able to support any possible combination of developers and users when required (e.g. Intelligent Infrastructure and an MDU; or an external supplier and a regional asset manager) rather than simply upskilling a small number of teams.

This should also include paths for escalating issues effectively, where those issues span different NR groups.

This is analogous to the NHS providing flexible midwife services to support the whole population, rather than trying to train the population to perform a vitally important, high risk activity, which they will do very rarely.

Action on NR (working group or ELT) to develop a communications support mechanism.

ORR expects to interview a sample of projects and find evidence that developer and user teams are aware of who they can contact for support on communications. We will collect examples of benefits or negative impacts.

REC 2 NR (working group or ELT) should define NR's culture around technology adoption; and develop a mechanism to disseminate this effectively to all teams across NR. This should consider:

- perceptions of other teams or processes as a help, not a 'barrier'
- the impact that decisions about adoption can have on NR as an organisation
- the role new technologies play in delivering NR's organisational objectives

Action on NR (working group or ELT) to define NR's culture around tech adoption and disseminate this effectively.

ORR expects to interview a sample of projects and find evidence that developer and user teams are aware of a shared NR culture around technology adoption. We will collect examples of benefits or negative impacts.

REC 3 NR should establish a mechanism for encouraging NR teams to learn lessons from other teams, relating to good practice and issues on technology projects. This could include improvements to the way lessons are recorded and archived, to make lessons more transferable (easier to digest and relevant to a wider audience). But primarily, NR should focus on when and how teams read the lessons recorded by previous projects.

Action on NR (working group or ELT) to develop mechanisms to encourage teams across NR to learn transferable lessons from technology projects.

ORR expects to interview a sample of projects and find evidence that developer and user teams can find lessons learned from previous technology projects, which are relevant for them. We will collect examples of benefits or negative impacts.

5. Appendix A – Case study transferable lessons

Case 1 – Plain Line Pattern Recognition (PLPR)

Case 2 – Expanded Polystyrene (EPS) station platform structure

Case 3 – Mobile Flash Butt Welder (MFBW)

Case 4 – My Work App on-site recording app

Case 5 – Wear coating for switch rails

Case 6 – Earthworks work-bank management tool

Case 7 – Structures consolidated database tool

Project name	(Case 1) Plain Line Pattern Recognition (PLPR)
Transferable lesson	**Focus on local champions early on – get senior buy-in when ready**
Key phrases	Successful lessons learned, good user engagement, find local champions
Technology type	Train-borne monitoring
Asset area	Track (plain line)
Users	Maintenance Delivery Units
Developers	Supply Chain + Route Services
Sponsor	Technical Authority

Key Facts

A software tool which scans images from train-mounted cameras and identifies defects in the track (e.g. cracks in rails, missing clamps etc) then reports these to local maintenance teams, to check and fix. Traditionally this was done by inspectors walking along the side of the track.
This is seen as one of the most successful examples of technology adoption (by NR and ORR) but, after 9 years, is still not adopted everywhere and issues are still being ironed out.

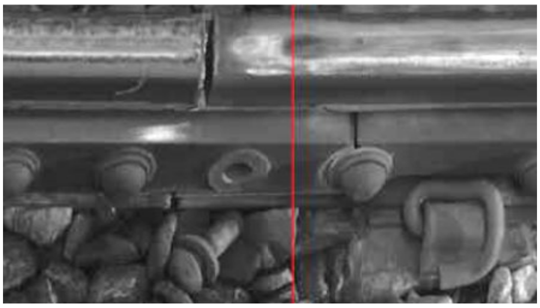
Areas for improvement

- Over 9 years and 2 periodic reviews, NR management had been pushing for greater adoption of this technology. Our review found that PLPR was only being used by MDUs on 75% of the mileage where the PLPR-equipped trains are running regularly, but the trains have not started running everywhere, so less than 60% of the total network mileage is using PLPR. The main issue is that all of the NR senior management who we spoke to were surprised by this statistic – they had heard only good feedback about PLPR and had assumed there was closer to 100% adoption.
- Processing the data has required 45 staff, working 24hrs a day, 7days a week in shifts. After 7 years of this, NR realised that 13% of this workload is false positives, some of which were making it to site and taking up inspectors time. The R&D project to improve this has been successful, but the costs from a 'teething problem' continued for 7 years.

Successes

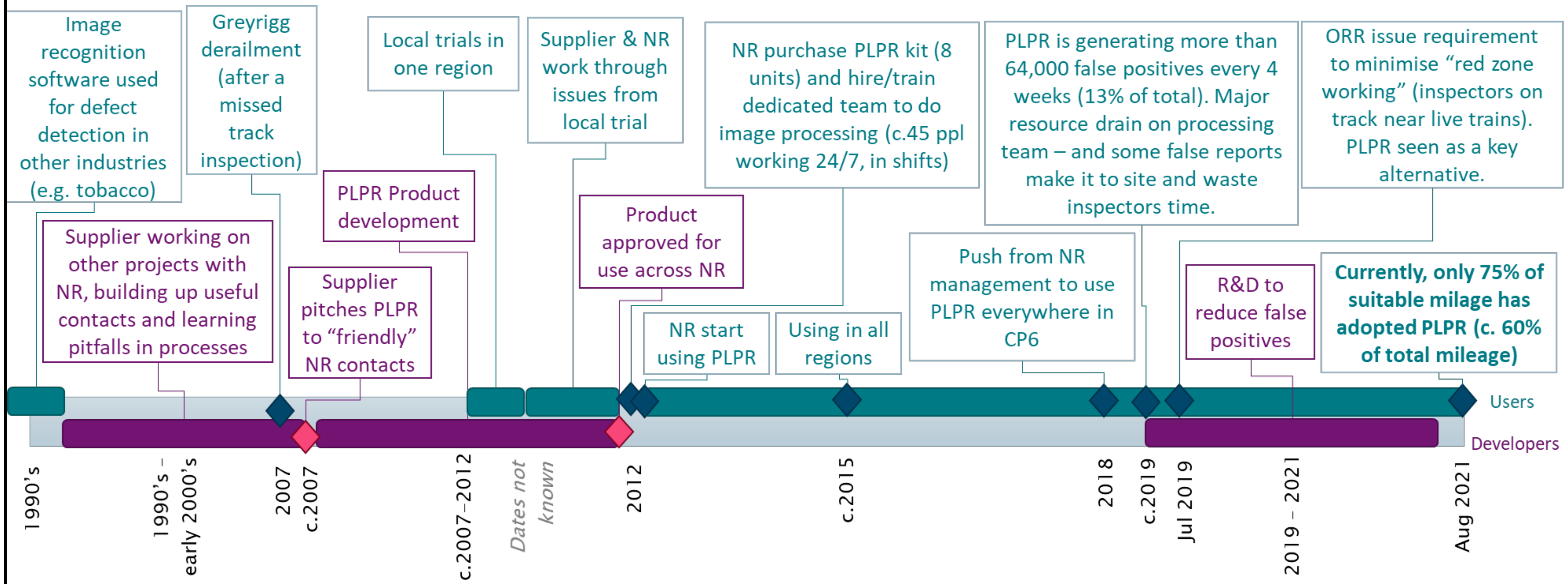
- The supplier really learned lessons from previous projects with NR, which had been difficult.
- they changed the things that didn't work before (this time they did as much development as possible talking only to a small group of enthusiastic local users, rather than going straight to the centre of NR).
- they took advantage of opportunities from previous projects (they had spent a lot of time on previous projects building relationships with people in the Unions – on PLPR they took advantage of the fact they already had a rapport).

Images

Project name	(Case 1) Plain Line Pattern Recognition (PLPR)

Timeline



Project name	(Case 2) Expanded Polystyrene (EPS) station platform structure
Transferable lesson	**People interpret information differently – try to make it unambiguous**
Key phrases	Ambiguity in standards and guidance, differing interpretations, subjective decisions
Technology type	Construction materials
Asset area	Buildings (station platforms)
Users	Regional Asset Managers
Developers	Supply Chain
Sponsor	Capital Delivery Project Manager + a Route Asset Manager

Key Facts

Polystyrene blocks can be used to support station platforms. These are quicker to install than conventional platforms and much lighter, so avoid the need for heavy plant or deep foundations and can be used on very poor ground.

Approved for use c.10 years ago but adoption was very slow – and 1 region is still refusing to use this "new" product.

Areas for improvement

- When EPS was first suggested to NR users, there was uncertainty about the new material (users did not know how EPS degrades over several decades, they had heard EPS dissolves on contact with some chemicals, that it floats, that it's plastic so it's environmentally harmful etc). The developers and sponsor spent 3 years collecting lab data and warrantees from manufacturers, to satisfy users and to achieve compliance with NR/GB standards. But…
- …Some users felt the people presenting the information were "salesmen" from the suppliers and lacked credibility on these technical issues.
- Some users (by their own admission) were not experts in chemistry/materials/environmental issues, so they did not understand the information and remained unconvinced.
- 7 years later NR issued a new environmental standard describing factors for consideration when selecting materials – but again, users were not experts in this area and interpreted the guidance differently. Some users are now rejecting the use of EPS based on environmental considerations in this standard – while Technical Authority are preparing a guidance note which supports the use of EPS, based on environmental considerations from the same NR standard.
- Because the decision to reject was based on subjective interpretation (rather than based on clear guidance from NR experts, or numerical analysis), users are reluctant to 'do a U-turn'.

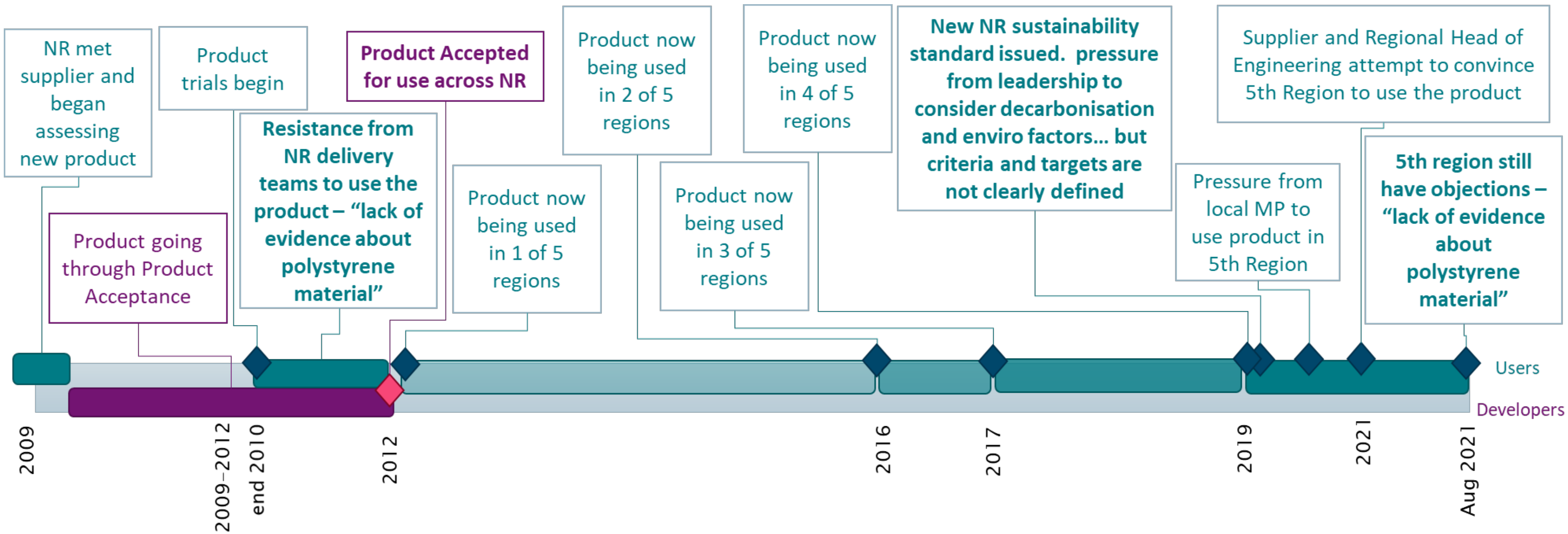
Successes

- Suppliers and sponsors continued to push for more adoption and they repeatedly challenged users who were resistant to adoption. Eventually, the product was adopted in 4 regions.

Image

Project name	(Case 2) Expanded Polystyrene (EPS) station platform structure

Timeline



Project name	(Case 3) Mobile Flash Butt Welder (MFBW)
Transferable lesson	**Understand your business case – and explain it to users**
Key phrases	Business case not explained to users, business case changed during development, lessons not learned
Technology type	Plant
Asset area	Track (plain line)
Users	Regional Asset Managers
Developers	Route Services
Sponsor	Technical Authority

Key Facts

A vehicle which can deliver factory-quality welds on site in 40mins, much faster than traditional “thermit” welding (4hrs) and to higher quality.

10 units were purchased c.10 years ago, but little adoption. Now selling off.

Areas for improvement

- When development started, defects from manual (alumino thermic) welding were a major issue. One of the benefits of MFBW is improved weld quality, so there was a clear business case. But…
- …8 years later when MFBW was delivered, manual welding had improved and the number of defects had fallen, so the quality benefit from MFBW became less valuable.
- But MFBW is also much faster, so it still had a business case. But…
- …once they tried to factor in planning the work, booking the plant (which was shared nationally), OLE isolations etc, users weren’t clear whether MFBW would give them any savings.
- NR procured 10 units soon after MFBW was approved, before checking it would be adopted.
- Some regions trialled the machines, to see how much they could deliver in a shift and how hard the paperwork was, but the new equipment broke down regularly, so users were put off.
- Adoption was low, despite occasional pushes (e.g. PWI talks about the benefits). After 4 years, MFBW delivered less than 2% of all welds, where NR was originally aiming for 33% of welds.
- Now after 9 years, some users are re-considering MFBW as a way to reduce renewals unit rates, so there is still a business case for MFBW – they are looking for guidance on the benefits and potential savings in different applications, but struggling to find it – and the users have heard that all the MFBW units have been sold, but this is no clear message on this from the NR centre.
- NR is now developing an Induction Welder, with many similarities to MFBW. Again, users are not clear on the business case for this, or if/when it will be available.
- Plant contractors have offered MFBW machines on some jobs, but NR has a negative view of it.

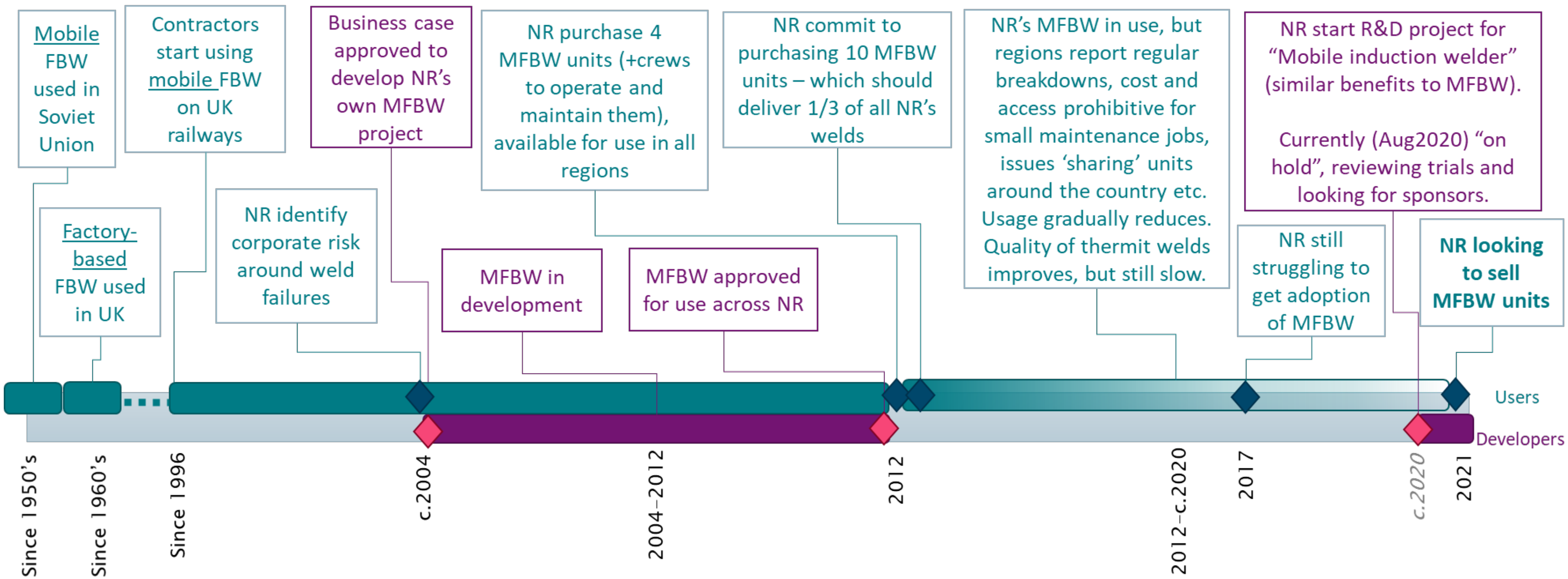
Successes

- NR senior leadership took notice of this example and it may have informed their future strategy.

Image

Project name	(Case 3) Mobile Flash Butt Welder (MFBW)

Timeline



Project name	(Case 4) My Work App on-site recording app
Transferable lesson	**Worry about ergonomics (easy to use, quick, everything in one place)**
Key phrases	Failure to understand user requirements, no trials before roll-out, no mechanism to address user feedback, training large number of MDU staff
Technology type	Mobile app
Asset area	Drainage & Lineside
Users	Maintenance Delivery Units
Developers	ORBIS / Technical Authority
Sponsor	Technical Authority

Key Facts

I-device (I-Phone/I-Pad) app which inspectors can use on site to input info (condition of assets, request for someone to come and do repairs etc). Previously using paper notes, manually entered into database.
1 of 5 regions did not adopt it – other 4 regions raised so many issues that NR decided to develop a replacement.

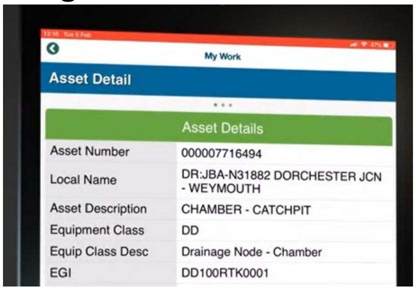
Areas for improvement

- The tool was developed by a special innovation programme (ORBIS). ‘User engagement’ during the ORBIS programme was with route representatives, rather than the actual users. Shortly after delivering the tool, the ORBIS team disbanded.
- The first users who were trained on the app gave clear feedback about the ergonomics (e.g. they had to click several times or scroll to get to the most common functions, items were arranged in the wrong order which wasted a lot of time). These items should have been easy to resolve, but there were no developers left to make the changes. The Technical Authority had to find staff with coding skills to edit the app themselves.
- One of the regions trialled the app but found that it took up to 15 minutes to locate one asset (GPS accuracy on I-devices was too poor to compare with a printed list of coordinates - and there was no map in the app, to see if the location looked correct). This region had set finding and documenting all their drainage assets as a top priority, so they decided they could not wait for the app to be improved and they procured their own app from a supplier. Their app does not integrate with NR’s asset database (ELLIPSE) so they have been double-handling data for the last 6 years.
- Technical Authority have also had to deliver training for more than 1300 users over 6 years – which they were not trained or resourced to do.
- After 5 years of negative user feedback, Technical Authority decided to start development of a new technology, to replace the My Work App.

Successes

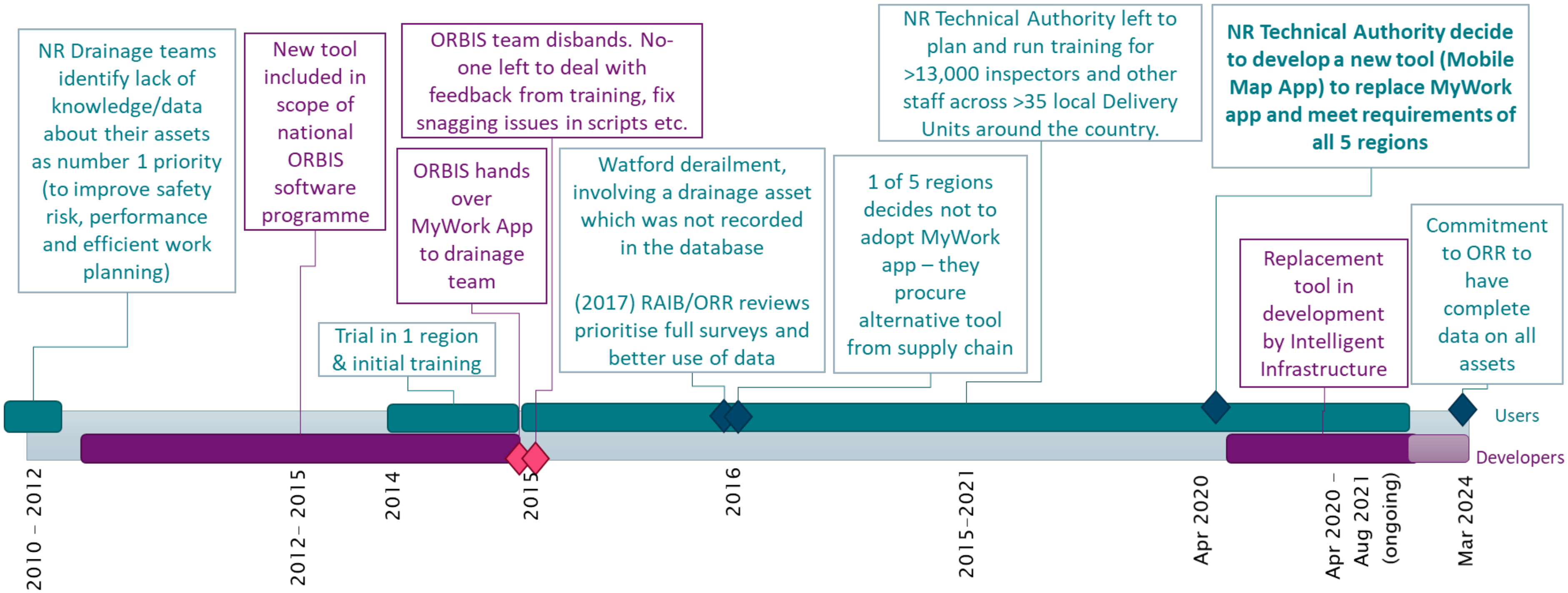
- Because they were forced to take on the role of developer, after ORBIS disbanded, the Technical Authority team have developed a much better understanding of app development and user requirements, which they are using in the development of the replacement tool.

Image



Project name	(Case 4) My Work App on-site recording app

Timeline



Project name	(Case 5) Wear coating for switch rails
Transferable lesson	**Are you qualified to run a scientific trial? If not – ask for help**
Key phrases	Repeated trials, teams only competent in their regular technical areas, lack of support or guidance on planning trials, supply chain frustration
Technology type	Construction material
Asset area	Track (Switches & Crossings)
Users	Route Asset Managers / MDUs
Developers	Technical Authority
Sponsor	Technical Authority

Key Facts

A tungsten-carbide coating, applied to rails in the factory to make them more wear-resistant. Used widely in other industries (e.g. Oil&Gas).

NR has been asking supplier to go through product trials for 5+ years. NR staff running the trial had no formal training in trials. Unclear whether trial results were pass/fail. Under pressure to resolve the trials, NR finally reject the product.

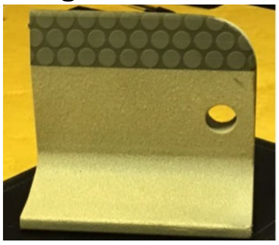
Areas for improvement

- Technical Authority's track team met a supplier with a product and they approached NR's Product Acceptance team to arrange a trial. The PA team do not have any engineering expertise within their team, so they delegate responsibility to engineers from elsewhere in NR – in this case they delegated it back to the same team from Technical Authority. But this team had no training or qualifications to run a scientific trial – and they had no support or guidance from other NR teams.
- The basis for the trial was to install the product at one site, then return in a year, inspect the rail and then determine if the product had provided any benefit. But there was no specification for what they would measure and look for, or what the pass/fail criteria was. There was no control experiment on very similar conditions but without the coating. There was no detailed plan to measure the train traffic over the trial site and there was no instruction to local maintenance teams not to tamper with the trial rail.
- At the end of the one year trial NR and the supplier struggled to agree whether the product had passed or failed the trial. Rather than learning lessons from this, the trial was extended 4 more times, lasting a total of 5 years and adding 5 more sites (some of which had to be abandoned because maintenance teams made adjustments to the trial rails).
- After 4 years NR invited a team from a University to inspect one of the sites. They carried out lab tests which concluded that the coating had completely worn off – but this was not conclusive proof of failure, because the coating was always intended to wear off while protecting the rail underneath. NR has now withdrawn the trial certificate, without approving the product.
- However, some of the local users involved in the trials liked the product. When we spoke to them they had not been clearly informed that the trials were withdrawn. Now some of them are contacting the supplier to try and begin the product acceptance process again.

Successes

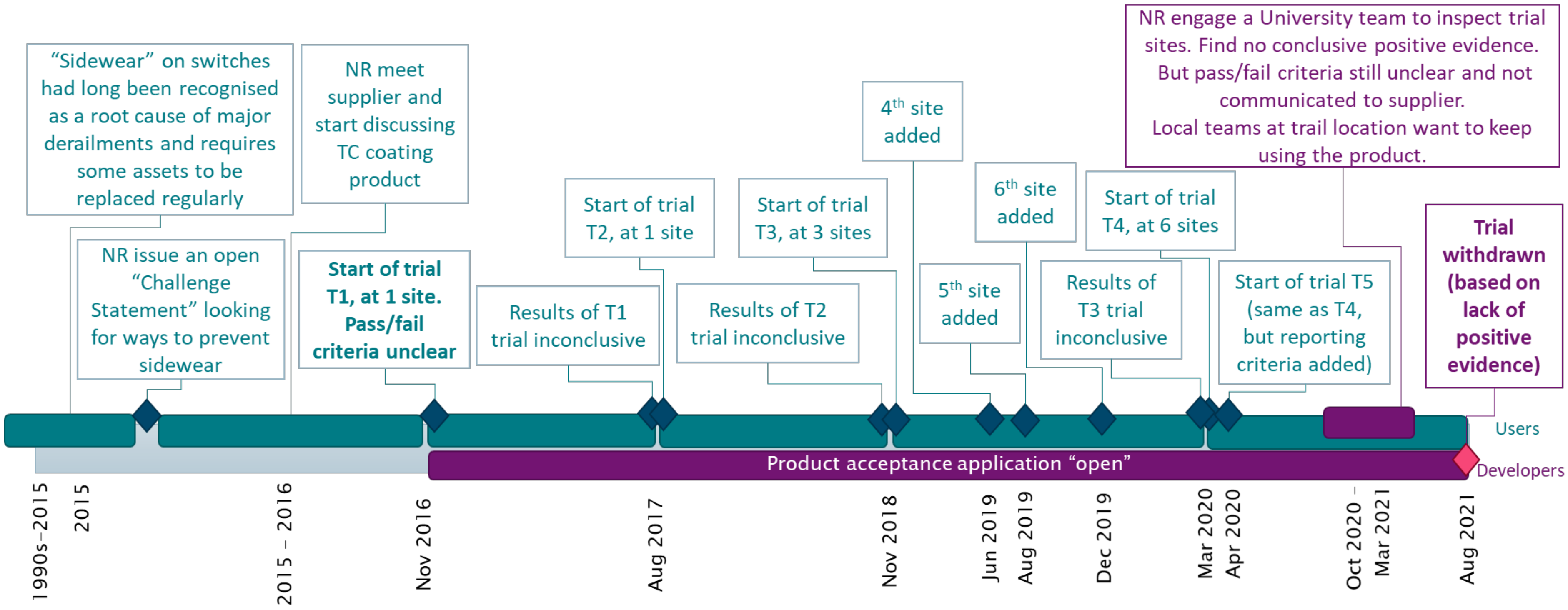
- Users involved in the trial understood the benefits and are pushing to adopt it.

Image



Project name	(Case 5) Wear coating for switch rails

Timeline



Project name	(Case 6) Earthworks work-bank management tool
Transferable lesson	**“ASAP” is not useful – any real deadlines? what happens if missed?**
Key phrases	Ineffective engagement, understanding user requirements, delayed delivery, interim deliverables
Technology type	Database / Software
Asset area	Earthworks
Users	Regional Asset Managers
Developers	CSAMS / Intelligent Infrastructure
Sponsor	Technical Authority

Key Facts

Software tool which brings together all data about earthworks assets and helps NR decide what work is needed over a 5-year period (and helps to update this as things change)

The tool was requested c.10 years ago and is still urgently needed.

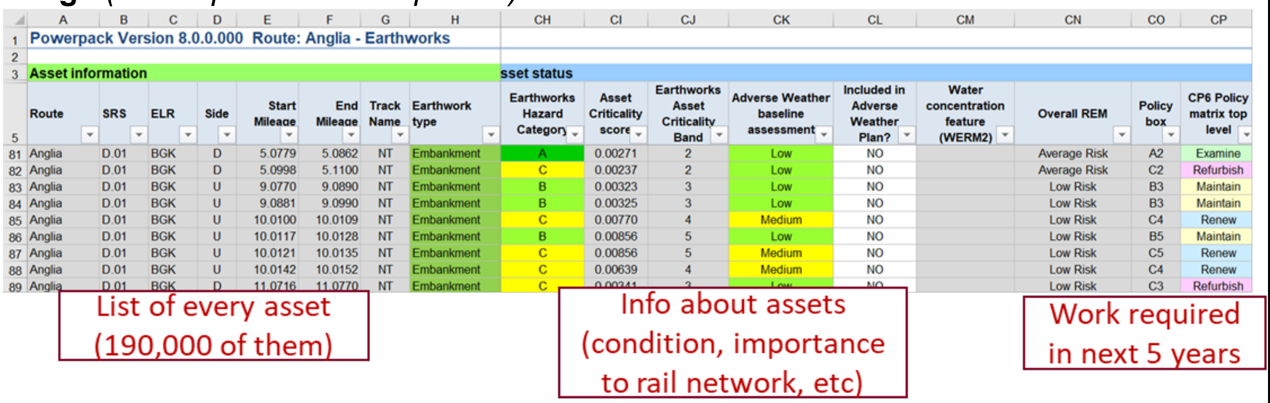
Areas for improvement

- The previous CSAMS tried to create 1 super-tool to do everything – after 6 years, failed to deliver anything and was shut down. Users lost trust in developers.
- Lots of engagement with users (weekly meetings with all regions + TA), but this was mainly developers trying to reassure users they are doing as much as they can.
- Users frustrated with ongoing delays, just keep demanding product “as soon as possible”.
- There was an urgent deadline for part of the tool, to meet CP7 planning milestones – but this was lost in communication – everyone working on the basis of “we need it all, as soon as possible”.

Successes

- Users and developers have shown great resilience to continue engaging on this project. This tool is still deliverable – but not if developers or users abandon it.

Image *(of the ‘proof of concept’ tool)*

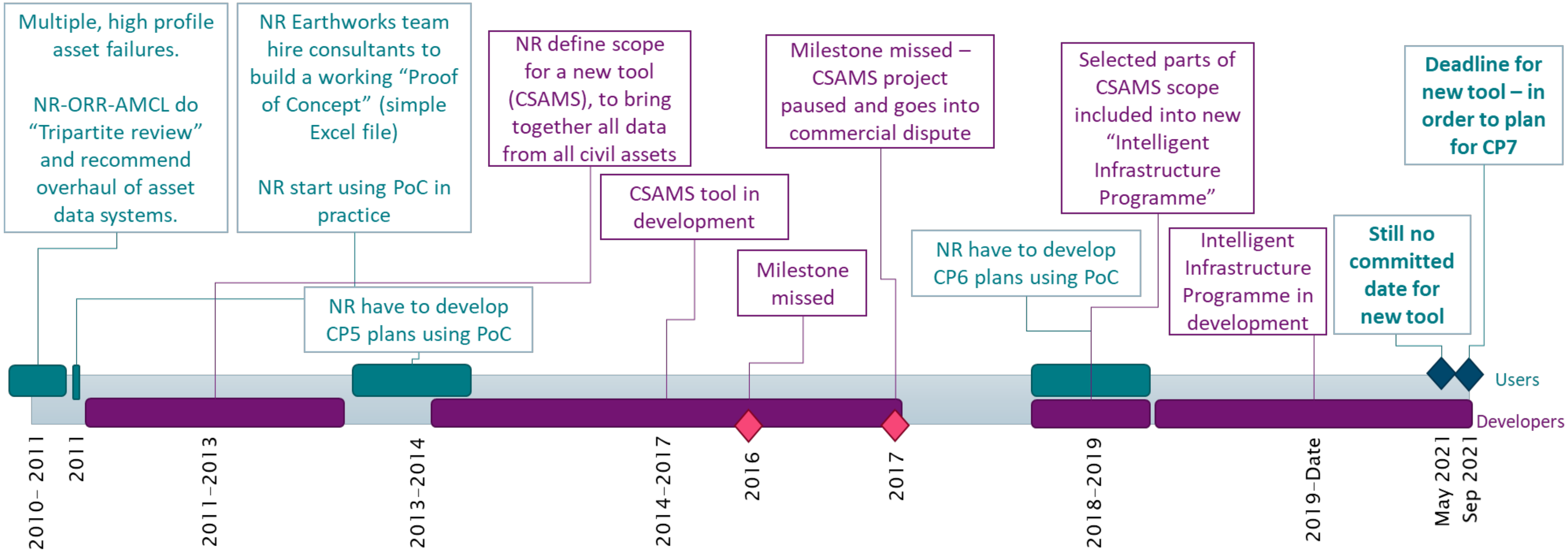


Powerpack Version 8.0.0.000 Route: Anglia - Earthworks

Asset information								sset status								
Route	SRS	ELR	Side	Start Mileage	End Mileage	Track Name	Earthwork type	Earthworks Hazard Category	Asset Criticality score	Earthworks Asset Criticality Band	Adverse Weather baseline assessment	Included in Adverse Weather Plan?	Water concentration feature (WERM2)	Overall REM	Policy box	CP6 Policy matrix top level
Anglia	D.01	BGK	D	5.0779	5.0862	NT	Embankment	A	0.00271	2	Low	NO		Average Risk	A2	Examine
Anglia	D.01	BGK	D	5.0998	5.1100	NT	Embankment	C	0.00237	2	Low	NO		Average Risk	C2	Refurbish
Anglia	D.01	BGK	U	9.0770	9.0890	NT	Embankment	B	0.00323	3	Low	NO		Low Risk	B3	Maintain
Anglia	D.01	BGK	U	9.0881	9.0990	NT	Embankment	B	0.00325	3	Low	NO		Low Risk	B3	Maintain
Anglia	D.01	BGK	U	10.0100	10.0109	NT	Embankment	C	0.00770	4	Medium	NO		Low Risk	C4	Renew
Anglia	D.01	BGK	U	10.0117	10.0128	NT	Embankment	B	0.00856	5	Low	NO		Low Risk	B5	Maintain
Anglia	D.01	BGK	U	10.0121	10.0135	NT	Embankment	C	0.00856	5	Medium	NO		Low Risk	C5	Renew
Anglia	D.01	BGK	U	10.0142	10.0152	NT	Embankment	C	0.00639	4	Medium	NO		Low Risk	C4	Renew
Anglia	D.01	BGK	D	11.0716	11.0770	NT	Embankment	C	0.00341	3	Low	NO		Low Risk	C3	Refurbish

Project name	(Case 6) Earthworks work-bank management tool

Timeline



Project name	(Case 7) Structures consolidated database tool
Transferable lesson	**If you break your deliverable into pieces – they will try to re-merge**
Key phrases	Scope creep, interim deliverables, theoretical efficiency which is undeliverable, lessons not shared
Technology type	Database / Software
Asset area	Structures
Users	Regional Asset Managers
Developers	CSAMS / Intelligent Infrastructure
Sponsor	Technical Authority

Key Facts

Software tool which will eventually combine 13+ separate databases, analysis tools and assurance trackers. Having these in one place would allow engineers to see complex issues and balance priorities – a but this was too big to design and deliver in one piece, so had to be split back into 13 deliverables.
The tool was requested c.10 years ago and is still urgently needed.

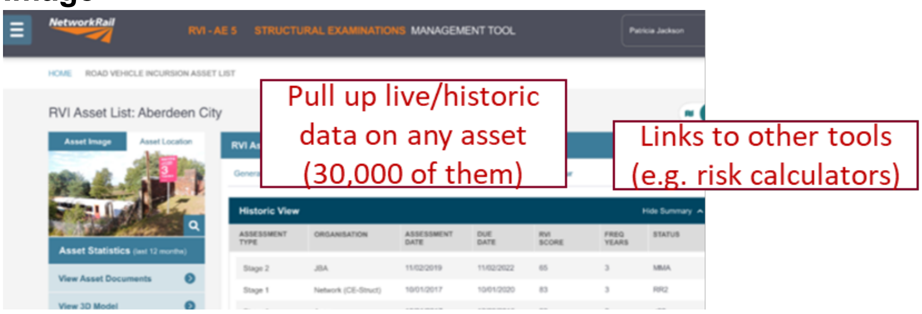
Areas for improvement

- Reviews of the CSAMS project identified scope creep as the main cause of failure. Developers kept identifying more datasets and functionality which could (theoretically) be combined into one tool. This introduced more technical problems to solve and more users to satisfy – and the tool could not be finalised until all parts worked. Eventually developers realised this was undeliverable.
- The CSAMS team produced a 'lessons learned' report. The Intelligent Infrastructure team (who took over some CSAMS deliverables) are now tracking themselves against these. However, the 'lessons learned' report was produced by external suppliers and is deemed commercially sensitive, so these lessons cannot be shared, for other teams to learn from.
- Intelligent Infrastructure have split the structures requirements into 13 separate tools, each dealing with a different dataset (e.g. examinations, scour risk etc), to avoid the CSAMS issues.
- But, users are saying that it would be far more useful to have all the data in one tool, so they can consider all factors at the same time when prioritising work. So users (especially those who were not with NR during CSAMS) may put pressure on developers to deliver the combined tool.
- Developers noted that they are under pressure for funding and resources because other projects are a higher priority, so they are seeking efficiencies. Developers also noted it is more efficient to solve one functional problem and share this across many tools – e.g. developers are working on a map tool which was originally required for a drainage app, but is also being aligned to other ongoing projects. This creates dependencies between several projects and funding streams.
- With both the users and developers clearly incentivised to combine several tools together, there is a high risk of the CSAMS issues repeating – especially if the 'lessons learned' are not shared.

Successes

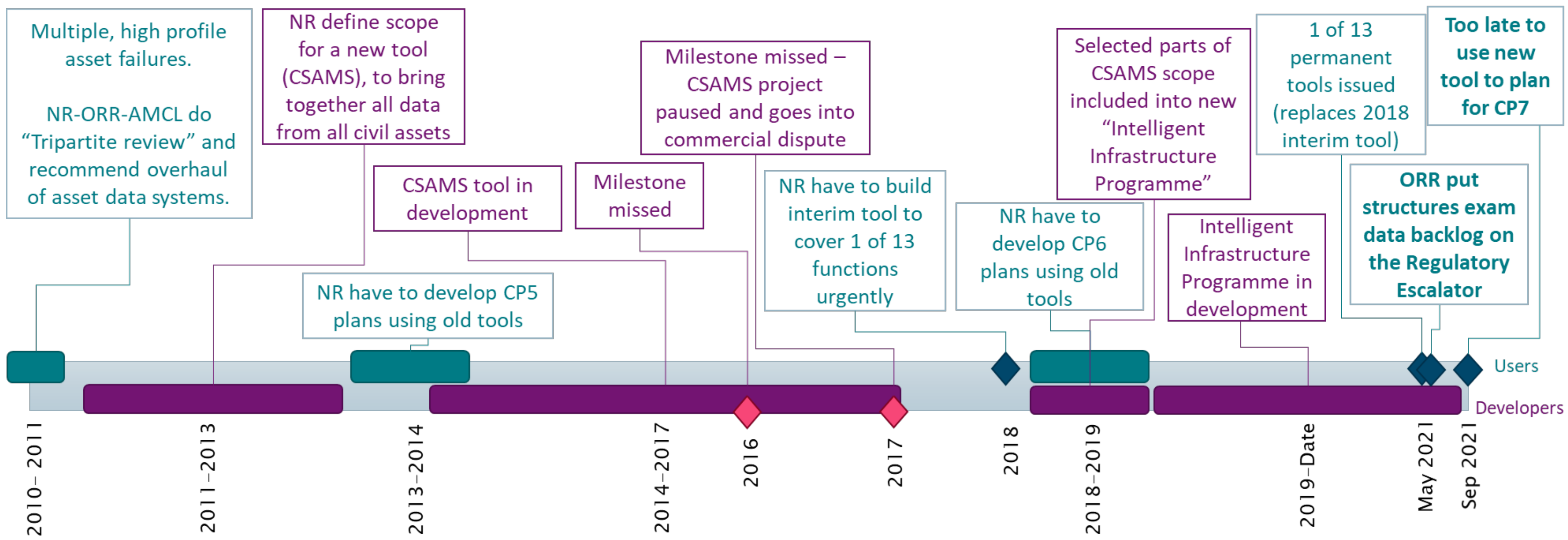
- Users had an urgent need for one tool (to manage a backlog of structures examination reports). Intelligent Infrastructure were able to split this deliverable out and deliver 1 of the 13 tools in 2021.

Image



Project name	(Case 7) Structures consolidated database tool

Timeline



6. Appendix B – Examples

Example 1 [return to text]

Case 6 – Earthworks work-bank tool: The developers attended a meeting where all the regional earthworks engineers get together every month. The developers presented details of complex software solutions to the users' problems. The developers noted that many of the technical details "seemed to go over their heads" for many of the engineers. After the meeting the developers emailed the engineers, attaching a detailed slide pack and asking them to approve their approach and priorities "using the voting buttons".

Example 2 [return to text]

Case 2 – EPS platforms: One user noted that they had raised some complex technical questions about the technology. The developers gave a presentation to try and reassure them, but they brought along someone from the supplier who the user said "was clearly a salesman, so I didn't know if I could trust him on the technical details".

Example 3 [return to text]

Under-sleeper-pads extend the life of concrete sleepers, providing significant cost savings on maintenance and replacement. They have been used successfully in Austria for many years. NR found there was a good business case so they went through development and successfully achieved Product Acceptance. When regional track engineers were presented with it, they all focussed on the high up-front costs to install it – and they quickly refused to adopt it. They did not get far enough into the assessment process to realise that it would significantly reduce the whole-life-cost of their assets.

[source: additional example provided by NR staff, interviewed as part of this review]

Example 4 [return to text]

Case 3 – MFBW: When the development started, the quality of manual (alumino thermic) welds was problematic, weld defects were a top priority and most users would have been incentivised to make changes which improved this. So, MFBW was clearly valuable.

However, 8 years later, when the MFBW equipment was presented to the users, the quality of manual welds had improved and this was no longer a priority, so MFBW was less valuable.

Another 8 years later, users told us that now the cost of renewals is a top priority – and they are incentivised to find ways to bring this cost down. Now MFBW appears valuable again, as a way to make renewals more efficient (but users are too late, because NR are in the process of selling the machines).

Example 5 [return to text]

Case 4 – My Work App: The app runs on I-devices (I-Phone or I-Pad) and most maintenance delivery units had some I-devices and some people who were comfortable using them. The new app was spread across NR by training a small number of users at a time, then sending them back to their delivery units to ‘convert’ others by showing them the benefits. In Scotland, many of the delivery units had no I-devices. For two years, they kept sending staff on the training courses, but every time they returned to their delivery units there was such a majority of people who were unfamiliar with the I-device technology, that the few converts gave up and went back to the old technology (paper).

Example 6 [return to text]

Case 2 – EPS: In 2019 NR published a new Environmental standard (NR/L2/ENV/015) which included guidance on environmental criteria to consider when assessing different materials and methods (e.g. how the material is produced and delivered to site; and potential impacts on local biodiversity). But it does not give guidance on how to measure these criteria, or their relative importance. Based on their interpretation of this standard, one region (Scotland) has decided to reject the EPS system on the grounds that it may be environmentally harmful. Other regions have decided that EPS is acceptable for use based on the same standard. NR's Technical Authority team are going even further and producing a document which compares the environmental impact of different platform structures (referencing NR environmental standards) – which indicates that EPS is preferrable to traditional systems in many cases. The Scotland region have seen a draft of this document and interpreted it differently, finding results and comments in it which are negative about EPS and support their decision.

Example 7 [return to text]

Case 5 – Wear coating: After initial discussions with the manufacturer, NR were not clear how effective this product would be at preventing side-wear on rails, so they decided to run a trial. The trial certificate was theoretically managed by NR's Product Acceptance team, but they do not have any engineering specialists, so they delegated it to NR's central track experts in the Technical Authority. This team had specialist knowledge of track engineering, but no qualifications or training in how to run a scientific trial. Essentially they decided to install the coating then return after a year and look for any benefits. There was no definition of what they would measure or the pass/fail criteria; no data recorded on the traffic which was running over the trial site, no 'control' test on a similar rail without the coating; and no instructions for local teams to record any adjustments they made to the rail. These are basic requirements for a scientific trial, which would have been obvious if NR had provided basic guidance, or an expert the team could speak to for support.

Example 8 [return to text]

NR are already running at least two trains around most of the network, equipped with a new technology called KLD which measures side-wear on rails, more accurately and more safely than sending inspectors to walk along the track. A former NR Track Maintenance Engineer (now working for ORR) attempted to start using KLD in his area. He found the process to book the KLD trains and manage the incoming data was relatively straightforward, but in order to make the change he needed to go through a confusing and time consuming process to justify the change in safety case to a series of regional managers. The developers had not provided any templates or guidance to assist with this. He did not have enough spare time to work through this process and eventually gave up.

[source: interview with ORR employee, formerly an NR TME]

Example 9 [return to text]

Case 6 – Earthworks work-bank tool: The developers told us that they have “excellent engagement” with users – they are asking representatives from all five regions to attend weekly meetings and they meet the Technical Authority twice a week. This had been going on for several years. Despite hundreds of hours of engagement, when we asked both groups what was the deadline for this tool, both said “as soon as possible – users have been waiting for 10 years”. We interviewed the users and, in less than one hour, we discovered that there was an urgent deadline to get part of the tool working by mid-September 2021, otherwise the entire planning process for CP7 would need to be done with inferior tools. In all these engagement meetings, this information had not been successfully communicated. We contacted the developers and asked them to confirm if they could meet this deadline and, while we were on the call, they were able to commit to a date of 23rd September. We contacted the users again several weeks later, but this committed delivery date had not been successfully communicated to them.

Example 10 [return to text]

Case 1 – PLPR: This technology uses train-mounted cameras to spot defects, rather than sending inspectors to walk along the track. The original business case would have used the number of inspections PLPR would replace to determine its value to NR. But when PLPR was adopted and the number of manual inspections reduced, NR did not make these inspectors redundant – they stayed on the payroll, so there was no cost saving. Instead they were re-assigned to inspect switches & crossings, which it was claimed helped to improve NR's understanding of failure mechanisms at those locations.

Example 11 [return to text]

Case 6 – Earthworks work-bank tool: A regional asset management team explained that in the run-up to CP7 more than a third of their resources will be working on work-bank planning. The new technology is much more efficient and should free up a lot of this resource, who would then be re-assigned to tasks including: looking at landslip hazards from land outside the railway (which is a major safety risk and a priority from a recent national review); or spending more time optimising the procurement for big renewals projects, which could then provide a cost saving.

Example 12 [return to text]

The Intelligent Infrastructure (II) team indicated that following briefing and training they provide a period of Early Life Support (ELS). This usually lasts for 6 weeks (but may vary by project) and is predominantly focused on ensuring bugs or critical defects to technology or usability are fixed. If defects take more than 6 weeks to fix, an extension could be agreed. If user feedback raised the need for additional features to be added to the product, this would go into an II backlog and would only be approved for delivery subject to additional investment and prioritisation. Users indicated that they were usually too busy to devote time to training, then more time to explore the new product and provide feedback within the 6 week period. If they looked at it after the 6 week period, had feedback, but there were no developers assigned to respond to their feedback, then it was likely they would not adopt the technology.

[source: interviews with NR staff as part of this review]

Example 13 [return to text]

One of NR's plant suppliers offered NR a demonstration of a new piece of technology (a mobile conveyor machine on crawler tracks, which can be driven into muddy excavations and convey excavated material back to wagons on the track). One of NR's regions (Northwest & Central) agreed to a trial on an active worksite. During the trial, the conveyor jammed. There was an NR regional director on site who was unimpressed and made the decision that the region would not adopt this technology.

[source: interview with supply chain as part of this review]

Example 14 [return to text]

Case 2 – EPS: In the one region which refused to adopt the technology, the decision maker stated that they would be willing to revisit their decision. However, their decision was based on their interpretation of the NR standards – and their interpretation had not changed. They felt there was a need for subject-matter experts within NR to provide clear guidance and support, to remove any ambiguity about how to interpret the standards. If that suggested they should change their decision then they would have a good justification to do so.

Example 15 [return to text]

Following an accident with a runaway machine on site, NR updated their safety standard (NR/L3/OHS/019) to mandate the use of a particular technology ("Rearguard") on all work sites. Users quickly realised that it took too long to set up and remove this equipment, so they were unable to deliver all their work within a shift. Users also noted that, in the time it took to develop the technology, plant had improved and runaways were less likely. So, NR applied for a "temporary variation" from their own standard so that teams did not need to use it. Now staff in some regions have gone for so long without using this technology that they have lost their competence and would have to be retrained if they needed to use it.

[source: ORR's business-as-usual monitoring of NR]

Example 16 [return to text]

Case 3 – MFBW: Adoption of the MFBW was poor, largely because users were not clear on the business case (e.g. is it to improve weld quality, or just to do welds faster? Is it just for renewals, or can it do maintenance as well? Can I use it under OLE wires? etc); and there was no-one on the user side championing the technology. At the CEO's request, NR produced a detailed 'lessons learned' report on MFWB.

Today, NR are developing a new 'Induction Welder'. When we asked users about the Induction Welder they said they were not clear on the business case and that they had exactly the same questions as they had for MFBW. When we asked the Technical Authority, they said the Induction Welder does not have a champion on the user side. These lessons were supposed to have been learned from MFBW.

Example 17 [return to text]

Case 5 – Wear coating: The first product trial proved inconclusive, because there was no clear specification of what needed to be measured and the pass/fail criteria. Over the course of five years, the trial was extended four more times and five more trial sites were added, but there was still no conclusive result, because no measures or pass/fail criteria were agreed.

Example 18 [return to text]

Case 7 – Structures database tool: The CSAMS project attempted to build a tool which brought together all the data from all civil engineering asset types. After six years it was determined that this was undeliverable and the project was "paused indefinitely". After two years of review, including a 'lessons learned' report, the structures deliverables were handed over to the Intelligent Infrastructure team, to deliver as 13 separate components. Now, another two years have passed and there are new NR staff who were not around during CSAMS (and some older staff) who told us in interviews "it would be better if we could deliver all 13 components together as one tool" and "it would be more efficient if we could develop these components together with some tools we're building for the other assets", both of which sound similar to the CSAMS approach.

Example 19 [return to text]

In 2018, NR were looking for ways to locate poor track geometry which could lead to "cyclic top" derailments. Centrally, NR decided to purchase 80 special measurement trolleys (at least one for each local delivery unit), which maintenance teams can run along the track to find problem areas. Despite more than 60 Track Maintenance Engineers attending the training, adoption was low. Feedback from the users was not compiled, so it is not clear exactly who has adopted this technology and why others refused to adopt it. Now, three years later, one region is still struggling with cyclic top issues and has decided to repeat the rollout and training of the trolleys – but nothing is being done differently, to address whatever it was that caused poor adoption the first time.

[source: ORR's business-as-usual monitoring of NR]

Example 20 [return to text]

Case 1 – PLPR: A supplier involved in the development noted that NR had already tried to develop PLPR for many years but had failed. Their approach only worked because they had just come out of several difficult projects with NR, so they had some enthusiastic local contacts in NR and a rapport with key people in the Unions. In their opinion, without this, the project would have failed again.

Example 21 [return to text]

Case 6/7 – Earthworks and Structures software tools: The Senior Programme Manager for the development noted that the users "didn't trust in his development team in this control period due to CSAMS failures and challenges" with the previous project failing to deliver for 8 years. In his opinion, a main reason the users initially engaged with him was through existing relationships from a previous role in an engineering team. Until the developers could demonstrate that lessons had been learned from the past programme in a transparent and open manner, there was a recognition from the programme that trust had to be earned and worked on with the end users.

Example 22 [return to text]

Case 4 – My Work App: NR's ORBIS team decided to develop the My Work App in the most innovative, most efficient way possible – a single app for the whole country. But NR's LNW route (now the Northwest & Central region) felt this did not address their urgent, local problems, so they decided it was more efficient and innovative to procure their own system – rather than collaborate to improve the national tool. For the last 6 years, neither the national nor the local tools have performed the task efficiently and now NR has to fund a replacement – and additional resources in the region to process data from their sub-optimal system.

Example 23 [return to text]

A leading UK energy supply company has a dedicated role of "Asset Adoption Manager", who is responsible for communicating between development teams and users to identify risks to adoption and produce strategies to maximise adoption. If there are issues around adoption, they seek alternative ways to extract value from the technology, either by using it in a different application, selling the equipment, or selling the intellectual property. As a minimum they would aim to recover the capital invested in development.

[source: interview with an ORR employee who had previously worked as Asset Adoption Manager for a leading UK energy supplier]

Example 24 [return to text]

One of the ORR review team recounted working in Kazakhstan, as an English-speaking designer with a Russian-speaking contractor. To communicate, they hired a dedicated English-Russian translator. This communication structure made engineers realise the challenge was not about "finding the right words to explain what you want" (that was the translator's job), or "making your point more strongly" (the translators removed the tone and emotive language anyway) – the challenge was about getting to the core of the issues, explaining why you want something and making the message as simple as possible.

[source: review team member's previous experience]

Example 25 [return to text]

NR's Head of Maintenance in Wales has established a dedicated Culture Manager, to improve consistency across all the local maintenance delivery units and to ensure they are aligned to the high-level priorities of the region. This is an excellent example of an organisation-led culture, rather than allowing local cultures to form organically…

…but ORR would challenge that the region will need to check that their culture remains aligned to NR's national priorities

[source: interview with NR staff as part of a separate ORR Targeted Assurance Review]

Example 26 [return to text]

Over the last decade, NR as an organisation have imposed a clear culture around Health & Safety, dramatically improving worker safety. Today you can see posters with NR's "10 Life Saving Rules" in every NR office (even in design or IT offices). There would be zero tolerance if anyone said "we've always done it that way" or "I know that's the right way to do it, but we're under pressure at the moment". This provides clear evidence that it is possible to change the culture of the entire NR organisation – and realise benefits from it.

[source: ORR's business-as-usual monitoring of NR]

Example 27 [return to text]

Case 5 – My Work App: After the development team disbanded, the Technical Authority had to take over training of more than 1300 local inspection staff, spread around the country. Technical Authority noted that for many of these users it was the first time they had done digital data entry (as opposed to hand-written paper forms) – and some users had to be trained how to use an I-Phone.

Example 28 [return to text]

Case 6 – Earthworks work-bank tool: By 2020, users had been urgently awaiting the new technology for 9 years. Not having this tool presented a clear risk in terms of efficiency and safety and the users had tried to escalate this issue in every way they could, but received no help in accelerating the development. In August 2020 a train derailment resulted in 3 fatalities and was associated with an earthworks asset. This triggered a series of national reviews and earthworks became a priority for the CEO. The national reviews recommended that this tool (and other earthworks tools) were needed urgently, the CEO was made aware of this, and immediately the developers were told to make this a top priority. An interim tool has now been released, but this only happened once the issue had been escalated to the CEO.

Example 29 [return to text]

Case 6/7 – Earthworks & structure software tools: The previous CSAMS project faced major challenges and after 6 years was “paused indefinitely” before producing any deliverables. An independent consultant was asked to produce a detailed ‘lessons learned’ report. However, because of a contractual dispute between NR and the CSAMS supplier, this report is treated as confidential and has only been shared with a small group of people – the majority of whom were already familiar with the project. As a result, other NR teams are not learning lessons from CSAMS and ORR has heard discussions in other NR teams, which sound reminiscent of the discussions that led to the failure of CSAMS.

Example 30 [return to text]

When mobile phone networks transitioned to 3G in the mid-2000’s, companies were rushing to put up thousands of base stations. Mistakes were being made but contractors were not taking the time to learn from them. Consultants were brought in and came up with a ‘traffic light’ system, which looked at mistakes on an individual project, identified the key project characteristics, then used these to warn future projects that they were at a high risk of repeating the same issues. Contractors were much more receptive to targeted messages from previous projects, because they had been alerted that it was directly relevant for them.

[source: example provided to the review team by ORR’s Consumer Expert Panel, Sep 2021]

Example 31 [return to text]

NR brought in expertise from the automotive industry to create new processes, to reduce the number of technologies which were developed, approved, then proved to be unreliable in the field. The Design For Reliability (DFR) standard NR/L2/RSE/0005 was issued in 2017 and is mandated for all new technology except software. DFR is essentially a process map which ensures that developers are engaging with users and suppliers at the right points in the process – and that they are considering key factors (e.g. who will make it? who will maintain it? what does it need to do, how many times, for how long? etc). NR also offer DFR training courses for the supply chain.

This review has looked at the DFR standard and interviewed its creator. While ORR agrees that formalising the process makes sure that the right people are speaking to each other on the right topics, this is still no guarantee that they will communicate effectively or make different decisions – which are behavioural and cultural issues, not processes.

[source: interview with NR staff, as part of this review]

Example 32 [return to text]

NR are currently developing a tool called FELIX, which measures wear on switch tracks and has been used successfully in Italy. The project sponsor (the person who makes sure the project gets all the funding and approvals it needs and generally 'champions' it) is an end user, a regional track engineer – rather than a technical expert from NR's central track team. This sponsor is very enthusiastic and has focussed most of their efforts on a detailed post-implementation process, to track where and how the tool is being used. They plan to continue as sponsor until it is fully adopted, in case they need to find additional resources to fix problems – as opposed to the developers handing the tool over to users then closing the project after a 6 week training period.

This is a good example of users communicating collaboratively with the developers, rather than just 'engaging'. The post-implementation period may also help to improve cultural norms, if users feel "we are refining the tool to meet our needs", rather than "they are asking us to make a change".

[source: additional example provided by NR staff, interviewed as part of this review]

Example 33 [return to text]

Most projects in the Intelligent Infrastructure Programme (which mainly develops software and electronic monitoring equipment) are now using the AGILE methodology. This comes from the software industry and breaks down development of a large product into short ‘sprints’. These sprints last just a few weeks, solving a few of the users’ requirements at a time, then issuing an incremental update of the product. The users test the update and give immediate feedback to the developers. This should mean that when the project completes and hands over the final product, the developers should have resolved most of the users’ issues – and the users should be familiar with the product.

Note: ORR challenged whether NR are sticking to the strict requirements of the AGILE methodology. NR are constrained because any ‘increments’ need to go through IT security checks before they can be given to users. In fact the ‘increments’ are closer to every 6 months, rather than every few weeks. These large increments become much harder for users to digest and they may ignore or turn against the technology, rather than trying to find and fix every minor issue.

[source: interview with NR staff, as part of this review]

Example 34 [return to text]

Sellafield is Europe's largest nuclear site and has the most diverse range of nuclear facilities in the world, including spent fuel management; waste treatment/storage; and infrastructure decommissioning. For several decades, there has been recognition within the UK for the need to accelerate the hazard reduction at Sellafield and that **existing technologies alone will not suffice – so we need to innovate**. However, despite efforts, the timely adoption of innovation has not always been successful for various reasons including: a perception that the regulator would not accept new methods that require safety approvals and permissions; difficulty justifying up-front costs, if benefits will take a long time to materialise; miscommunications across different stakeholders who were each trying to achieve accelerated hazard and risk reduction at the site… and many other issues which are similar to those ORR has found in Network Rail.

A review of the corporate strategies of key stakeholders (infrastructure managers, regulators and government bodies) identified that accelerating works was a common goal. However, applying these strategies individually was not delivering progress at the rate desired. In 2013, ONR realised that the 'traditional' approach to regulation by setting targets and requirements was not helping to accelerate works. Closer collaboration between the key stakeholders was needed – so ONR established a 'G6' stakeholder engagement group.

At the initial 'G6' meeting, all parties resolved to work together towards the common goal and a set of strategic themes was developed. This new approach required parties to engage in realistic and collaborative dialogue to fully understand the issues that need to be resolved, and then take effective, coordinated action to ensure accelerations are achieved in practice.

A key feature of the G6 is its voluntary nature – all members have independent duties and responsibilities, and it is crucial that these are not diluted or infringed through participation in the collaborative process. As such, the G6 has no chair, but instead provides a forum where blockers can be identified, issues discussed, and initiatives sponsored and encouraged in the interests of achieving improvements on site. ONR have seen significant improvements in alignment and communication and a reduction in barriers to new technology. While the Sellafield site continues to grow ever more challenging and urgent, this proactive step by the regulator has ensured that solutions are still possible.

[source: discussions with Office of Nuclear Regulation as part of this review and publicly available documents [2], [3]] This publication is available at orr.gov.uk

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