An introduction to DFR and what it is

Kevin Rayment, Reliability Process Manager (Technical Fellow), Technical Authority, Network Rail, explains further.

Design for Reliability (DFR) at Network Rail is a structured process identifying minimum requirements for suppliers to demonstrate that they have designed reliability into new or changed railway products. It applies to controlled products that require an engineering assessment, leading to a successful Product Acceptance (PA) certificate to allow them to be used on the live railway. DFR adds a reliability element to the previous, almost exclusive, focus on the legal and safety elements of PA. However, although DFR focuses on reliability, it also further assists safety, as reliability products need less manual intervention that exposes workers to trains and eliminates both safety and non-safety-related asset failures.

Network Rail expects suppliers to provide evidence of using proven reliability tools and techniques within the DFR framework when submitting items for Product Acceptance (PA) and during supplier selection, and puts greater emphasis on sharing causes of historic failures with suppliers to assist this than was done previously. The reason for the strong link between DFR and PA is that there is no point in mandating something such as DFR if there is no means to confirm it is being correctly applied. Network Rail's role as a European Rail Infrastructure company means that it must follow strict rules to allow a level playing field for any potential suppliers. The result is that it is impossible to keep a totally accurate list of all these suppliers, as someone could create a new business to supply Network Rail at any time. On top of this, the products Network Rail purchases are installed from Penzance in the south-west of England to Wick in the north of Scotland. There is only one intersection that all these navigate and that is Product Acceptance.

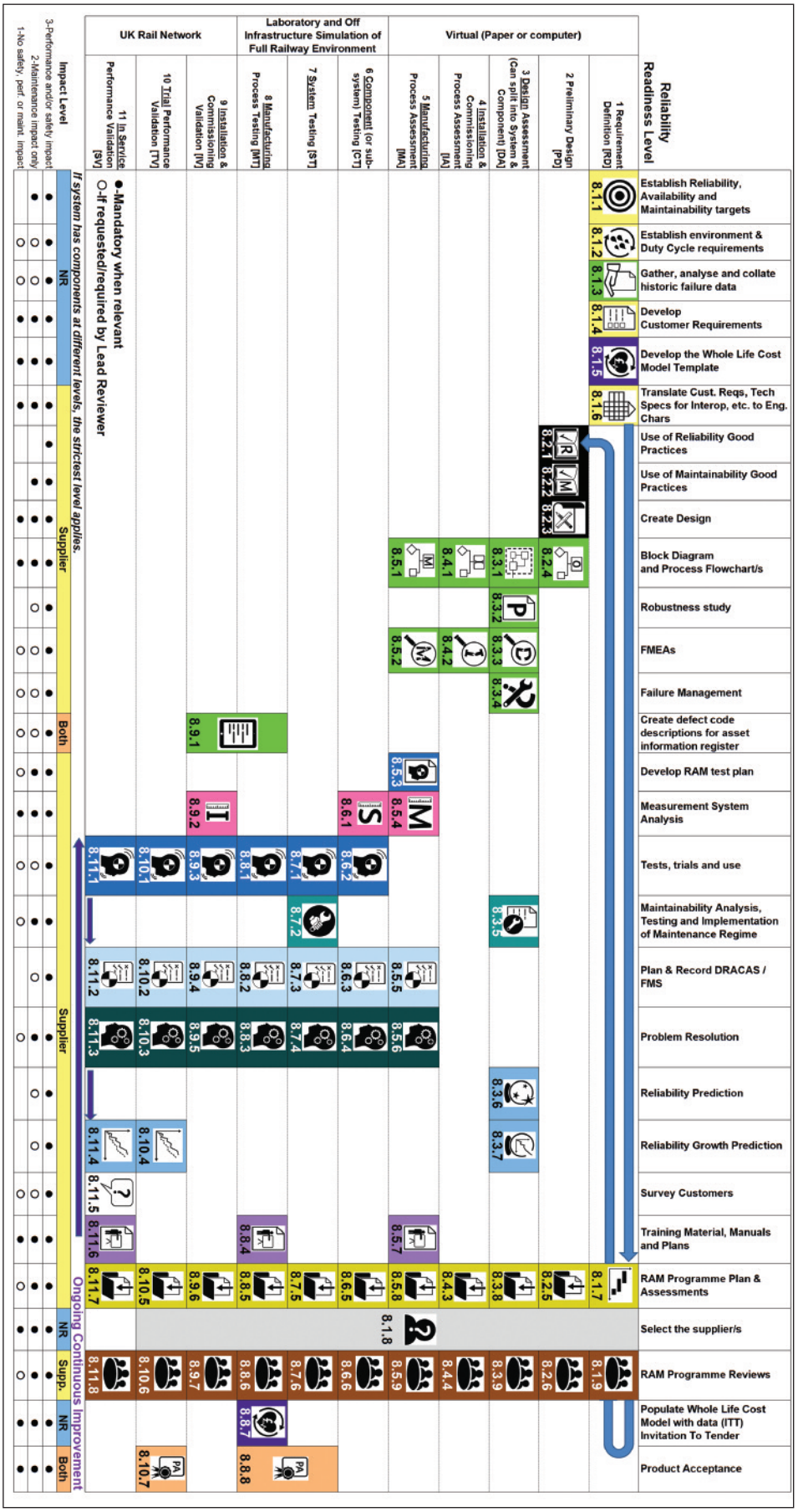
Reliability is only part of it

DFR was designed to address prioritised potential causes of unreliability, whilst also considering whole-life cost as it is not about achieving reliability by gold plating everything. Therefore, we need a smart approach to how we apply DFR rather than having a one-size-fits-all approach. For certain paths, as few as 11 of the 79 possible steps in the process, as shown in the table right, are required. Later in these articles, you will see how to select the path through the DFR process, such that each step adds value for a given situation. When applied to product changes, DFR expects the most appropriate methods to be used to confirm that correct cause/s are identified and addressed.

DFR was mandated from 3rd April 2017 by Network Rail's Business Process NR/L2/RSE/0005, first issued in June 2016. A 15-minute overview video can be found at: vimeo.com/601894363/9c650c97b0

W Edwards Deming

Many of the tools used in DFR are from an approach called Total Quality Management based upon the ideas of an engineer, statistician, professor, author, lecturer and management accountant born in 1900 called W Edwards Deming. He was invited to Japan after World War II, due to his statistical background and involvement in the 1951 Japanese census. He went on to be involved in the reconstruction of Japanese industry and establishment of statistical control methods. Deming has much to do with the fact that in the past Japanese products were often considered to be of inferior quality, but now generally have the opposite perception. In 1980, an NBC White Paper documentary called, 'If Japan can, why



The DFR 'periodic table' showing the steps that may be required in different situations.

can't we?', came to the attention of Don Peterson, Chief Executive, Ford Motor Company, who sought his help. When Peterson asked some of his direct reports to invite Deming to help, it is understood that, initially, Deming said no because the request was not from the top, showing senior management commitment to quality. Once Peterson invited Deming to talk to him himself, he then agreed. Andrew Haines, Chief Executive, Network Rail, expressed his personal support for reliability at the quarter 3 business briefings in 2020 when he said: 'I am passionate about reliability… It really is the driver of customer satisfaction like no other… Our railway has to deliver both safety and reliability if we are to attract passengers back.' This was with particular reference to making the railway appealing to customers again as it recovers from Covid-19. In 1960, Deming was awarded Japan's Order of the Sacred Treasure, Second Class, and the prestigious Deming prize in Japan is named after him. Deming is particularly well known for his 14 points for management. I will mention Deming's points and how they align to elements of DFR as we move through these articles. However, there are some that either align with the whole of DFR or are not relevant to a specific step, so are worth covering here.

Deming's point 1 is about having a constancy of purpose and thinking ahead rather than just thinking about short-term problems. Stick to a commitment for better products. Point 2 is about adopting a new philosophy as it is unacceptable to continue to accept poor quality levels that we may have accepted in the past. Point 7 is about instituting strong leadership in the business, who look to improve the underlying processes that people must work within. Point 8 is one of the most well-known of Deming's points and identifies the need to drive out fear from the organisation, as fear can be a barrier to people being willing to identify issues and propose improvement if such information is reacted to negatively. Point 10 may appear unusual, as it is about eliminating slogans and posters focused on telling the workforce to do better. This ties in with point 7 about needing strong leadership. Posters are just an easy action, rather than the creator of the poster actively doing something to help. Such posters may suggest that others must be the cause of problems rather than the person who created the poster taking any accountability to help resolve things.

Point 11 is about eliminating the use of high-level meaningless management objectives. Very often, detailed measures based on understanding a process are replaced with a much lower number of very high-level measures. This simplification often loses the original reason for the metrics and, in some cases, means that the metric can be hit despite actually making things worse! Many years ago, I was driving to the airport very early in the morning and listening to Radio 4. They played some classical music and announced the first programme of the day, which I believe was called, 'Farming Today'. The first story was about a new rule to protect wildlife, which proposed that if a farmer had not ploughed a field for a certain number of years, they would no longer be allowed to do so in the future. What reaction do you think that some farmers may possibly have had to this?

They may have run from their farm kitchen and jumped on to their tractor before the report was even over and started ploughing any field that had not been ploughed for a duration approaching that being proposed! I suggest when setting such metrics, you become devil's advocate and think if there is something you could do to better meet the metric, which is counterproductive. If you can identify such an action, then it is not a good metric. Point 12 is about removing barriers to pride in workmanship. This one is possibly the most controversial of Deming's points. This may sound surprising, but it is due to one of the causes that Deming states, which is something that typically occurs once or twice a year. This is the annual appraisal. People are often measured against things that they have no control over. On the flip side, personal goals may also discourage people from helping someone else to achieve a more important goal for the business, than the one they were originally set.

Kevin Rayment gained his passion for continuous improvement at Ford Motor Company, where he was Quality Supervisor at Dagenham Body and Assembly Plant. He was on the first waves of Ford's Six Sigma Black Belt and Master Black Belt training and then headed up, and deployed, Six Sigma into foundries, V-Engine plants, automatic transmission design and diesel engineering. Following time as the Quality and Reliability Supervisor for European diesel engines fitted into Jaguar vehicles, Kevin joined Network Rail to deliver its Maintenance Six Sigma Programme, which led to significant savings. He is also Deputy Chair of the IMechE's Safety and Reliability Work Group.

Not Einstein!

I will use quite a few quotes throughout these articles, which I have tried to attribute correctly, as an amazing number seem to be incorrectly attributed to Einstein! The quotes do not necessarily reflect the opinion of Network Rail and are here as thought starters. The first quote I want to mention is, 'Inspection to improve quality is too late, ineffective, [and] costly. When product leaves the door of a supplier, it is too late to do anything about its quality. Quality comes not from inspection, but from improvement of the production process.' This comes from W. Edwards Deming's book called, 'Out of the

Crisis' from 1982. Do you agree with this quote? You can fix and improve afterwards, but a supplier's reputation may have been harmed by that time. Quality and DFR should be about getting it right in the first place rather than correcting it afterwards.

Even the manufacturing process mentioned by Deming can be too late, and we should try and design issues out at the earliest point in the design process. If you make an item and scrap it due to poor quality and make another it has cost the supplier twice as much. The cost of a product failing on the railway may cost Network Rail far more than the purchase price of the product. It is not practical for Network Rail to pass the contractual Schedule 8 payments made to train operators for denying access to a train path on to the responsible suppliers, as this may put some small suppliers out of business and hence exacerbate issues. DFR is a pragmatic way to reduce this risk by working with suppliers instead. It can almost be seen as an analogy to an insurance policy against such delay payments. We will talk more about Deming later in these articles.

Jargon busting!

As with many activities, reliability has some jargon that we need to understand so people can communicate easily and efficiently when discussing the topic. Reliability is the probability that an item is able to perform a required function under stated conditions for a stated period of time or for a stated demand. As you can see, it is a probability, so we talk about things having a reliability of 50% or 90%. Understanding reliability must start with recognising what the function of a product is and what we expect of it. Without this how can we tell if it is reliable or not. Part of what we expect of something is for it to operate in a particular environment with associated conditions. Reliability is also time-bound in that an expected life should be stated. If you went to the supermarket and paid 5p for a plastic bag and, as you carried your shopping out of the door, the bottom fell out of the bag and your food fell on the floor, would the bag be reliable? No, as the required function is to be able to carry your shopping home using the bag. How about if you decided to be environmentally friendly and reused that plastic

bag every week for a year and, at the end of a year, the bottom fell out of the bag. Would that bag be reliable? Yes, as it is only designed as a one-time use bag. However, if you bought a 'bag for life' and, as you carried your shopping out of the supermarket after a year, the bottom fell out of the bag and your food fell on the floor it would not be reliable, as the stated 'life' suggests that it should last beyond a year. Reliability is also dependent upon the product being able to be used in stated conditions. Have you ever dropped your mobile phone in water? Did it continue to work? Does this mean it is unreliable? Not if it is not designed to work under water! If you did this to a newer phone designed to work under water and it stopped working, then that would be a reliability issue. Suppose I decided that the 'bag for life' was just the right size for my 16lbs bowling ball and, on the way to the bowling alley, the bag split. Is that bag unreliable? No, as it is designed for the demands of carrying supermarket products, not bowling balls.

'Robustness' is often confused with 'reliability'. This is probably as they both begin with the letter 'r' and are related to the idea of 'quality'. However, robustness has a very specific meaning with regards to quality. It is 'low functional variability in the presence of noise'. This gives us a new challenge in terms of understanding, as it uses the term 'noise'. This does not mean that something does not work correctly when we shout at it. Noises in the context of reliability are things that can change that are difficult, expensive, or even impossible to control. These are not things like whether we make a product out of wood or steel, as we can control that. These are things like variations in dimensions due to manufacturing variation, the weather or stray electric fields from nearby electrical items.

Most DFR activity should occur very early in the design process and starts when requirements for a product are created. You may have heard people say things like, 'It costs 30 times as much to fix something once it is in production, than during the design stage'. The numbers and the words are often varied and inconsistent, but such statements can be traced back to a paper written by Boehm in 1981. Boehm's study was on software but, when you think back to 1981, the peak of home computing would have been the likes of a ZX81 with 1kb of memory and office computers probably had large spinning paper tapes. The similarities of software to railway products were, therefore, much more similar than they are today when you can download a software patch over the internet. If software had an error, the user would probably have to wait for a box containing a paper tape to arrive through the post. The most important point to note is that applying DFR far too late, even as late as when applying for PA for a finished product, takes just as much effort and cost as doing it early, but offers the chance of far less benefit due to missed opportunities and any changes that are still feasible being far more expensive later in the process.

DFR has certain underlying principles. It aligns with the philosophy of Structured Continuous Improvement and, as such, is not something that you do for a set time and 'complete'. Stopping DFR would lead to a return to recreating issues that existed prior to DFR. The effort to sustain DFR is much lower than that to initially implement it and so that would be a huge loss. Once an initiative has been stopped, it can also be much more difficult to restart it again, as stopping something can bring negative associations for an initiative regardless of the reasons.

Getting the message across

It is key to train and support suppliers and Network Rail staff together, so they hear a common message, with Network Rail attendees knowing what they should expect of suppliers (which is especially useful when assessing evidence or giving support) and suppliers knowing what they should expect of Network Rail (especially during the setting of requirements at the start of the process). This clear, common message also makes the process auditable compared to a more ad hoc approach. The use of rail examples rather than trivial everyday ones is also important in explaining how DFR should be applied.

In terms of resourcing a move to avoidance activity, it is not appropriate to just suddenly move all resource from resolution to avoidance, as there is a time lag between starting avoidance work and a fall in the need for resolution activity. Even after the introduction of a very successful avoidance initiative, a few issues may remain and require some level of resolution work. The people checking DFR evidence should be different to those providing coaching and advice, to avoid any conflict of interest or undue feeling of pressure to approve something that requires further work.

There has been much emphasis on trying to accelerate the PA process to speed up innovation. It is fair to criticise such a process if the assessment process is inefficient or under-resourced, but if delay is due to missing evidence (which is often the case), unclear submissions or lack of interest in making a product suitably reliable at a cost that represents value, then that is not the fault of the PA process, but rather a valid challenge of the product. Some issue that DFR will identify and address may have been spotted if ad hoc methods had been used. However, the thoroughness and structure provided by DFR is intended to spot the less obvious causes of unreliability that can slip through the net and cause high levels of passenger and TOC frustration, cost, and unnecessary additional work. If a supplier passes work to a lower tier supplier, then they are still expected to provide evidence. This logically must be the case with such an initiative, else it could potentially promote the creation of layers in the supplier structure allowing certain suppliers a short-cut path to product acceptance due to outsourcing with Network Rail carrying the risk of omitted evidence of such outsourced activity.

Training courses

There are a number of upcoming DFR (online) instructor-led Network Rail courses which can be of use to anyone wanting to know more about the subject:

- **DFR introduction.** 3rd - 7th October (five half-days) - free to participants for a limited time with priority given to those railway suppliers who are yet to attend.

To book, just email your name and email address details to: dfr@networkrail.co.uk

There are also more advanced courses available:

- **Potential Failure Mode and Effects Analysis (FMEA).**

26th - 30th September (five part-days).
7th - 11th November (five part-days).

- **Quality Function Deployment (QFD).**

12th - 16th September (five half-days).
10th - 14th October five half-days).

There are a number of methods for booking on these courses, depending on the participant's situation:

- Network Rail Central Functions - log into Oracle (E-Business Suite). Click 'OLM learner self-service Network Rail' - Search for Design for Reliability and click 'enrol in class' for the desired course. System will advise, 'This class is in planning stage, do you still want to enrol in this class?' Select 'Yes' and your status will change to 'Requested'.
- Network Rail Routes and Regions delegates via regional training teams - contact your Route Training Support Manager (RTSM).
- Non-Network Rail delegates - go to www.networkrail-training.co.uk/courses-for-non-network-rail-staff/ click, 'Course sight' and then click 'Sign up' to register a company and set up an account. Search and select the course, venue and date - confirm the number of places you are buying and provide payment card details.