13 New Train Procurement

Since this is a handbook for reliability improvement, we shall concentrate on how to buy a new train fleet to get the best 'out-of-the-box' service performance. It is written primarily from the perspective of TOCs because they need to be key players in the procurement of new trains. They have the best knowledge of what they and their passengers need and want, and they will be first in the firing line if the product, and particularly the reliability of the product, falls short. We have therefore set out some lessons learnt, based on recent procurement experience. This is not expected to be completely comprehensive, but intends to raise awareness of issues which can inform future thinking. Equally, this section may be applicable to the installation of new equipment onto trains.

Two powerful lessons learnt are that to maximise reliability, new train procurement demands:

i. the effective deployment of significant train operator resources - this costs money but pays reliability and other long-term dividends; and

ii. adequate timescales, and sufficient contractual rights to enable the TOC to demand that deliverables are right at each stage of the project (so it is not under time or financial pressure from other stakeholders to accept an inferior product).

13.1 **Pre-Contract – Product Selection**

13.1.1 **Planning**

It is worth investing serious time and energy in this phase of the project, hence the recommendations in the pre-contract and contract sections of this Section are the lengthiest. There are some things which must be done for legal reasons (such as issuing an OJEU notice) but our focus is on practical steps which we recommend to improve reliability, based on positive and negative experiences of either doing or not doing them.

Critical to efficient implementation of the eventual train service is the early and effective engagement of the TOC's Operations and Commercial functions. This sets the train in the context in which it will be used, e.g. what the needs of the passengers on the route are, what the roles of on-train staff are, how other trains on that TOC work, etc. It is best if the TOC frees up some of its own staff who know how their railway operates, its constraints and opportunities, rather than hiring consultants to do the job for them (although long-term secondees can be worth having if they become an integrated part of the TOC team).

A one team integrated approach should be adopted early on, bringing operational staff, engineering and commercial aspects of the business on a full-time basis; the team should be cross organisational, preferably with knowledge and experience in fleet introduction. It can also be worthwhile to include representatives from Network Rail, front line staff and driver representatives in cross company workshops with wide engagement.

No matter how tightly the contracts are written, the TOC always has risks that cannot be fully passed back to other parties:

- Safety - the ultimate responsibility to run a safe train falls on the TOC;

- Overall business risk - performance regimes with manufacturers to deal with poor performance are invariably capped, and based on an estimate of possible TOC losses inevitably made years before the trains enter service.

Recognising these risks, Heads of Terms and a detailed Train Specification (setting out how the manufacturer will deliver a product compliant with the TOC's functional specification) should be agreed before any preferred supplier is nominated. The more time spent at this stage, the more successful train implementation has been, in terms of: fewer (expensive) variations to contract during the project; higher reliability out of the box; lower risk of an overspent manufacturer being unwilling (or unable) to finish the job properly.

Further, there is a correlation between the time available for the whole project and successful implementation: heroic timescales are less likely to produce good trains. Higher out-of-the-box reliabilities have been achieved with more generous implementation timescales: this gives the TOC the ability to say no (or even to credibly threaten to say no) at critical milestones in the development and delivery of the fleet, providing real leverage to ensure quality requirements are met.

Obviously, however, there is a balance: project timescales cannot simply be allowed to drift. Strong project management, with the ability to "fire a shot across the supplier's bows", will assist in achieving this balance.

13.1.2 **Specification development**

First, understand the core requirements. These may be set out in the franchise process, and are supported by many detailed requirements in TSIs.

Where these requirements are set out in the franchise process, often the opinion is formed by the DfT - in line with the Rolling Stock Strategy - and customer focus groups as to what they would like to see in the next franchise, rather than input from the current operator themselves.

The process can be either prescriptive (by Invitation to Tender) or cooperative (by Invitation to Negotiate), the later was the approach taken by Eurostar, highlighted below.

Example: Eurostars' process of tendering for new fleet was unique in that Eurostar issued a 'tender to negotiate', looking for a high-speed TSI compliant platform that would suit. Then Eurostar worked with the supplier to build the specification around what was possible.
Eurostar are fortunate in that their infrastructure is largely TSI compliant so there was good knowledge in the supply chain of system requirements and products were already on the market that could be easily modified for Eurostar operation.

The core requirements should cover:

- Train "technical" issues e.g. route-specific performance parameters such as top speed, kinematic envelope;
- Train "passenger" issues e.g. passenger carrying capacity, ambience, facilities;
- Train "depot" issues e.g. fuel, coolant, sander and toilet interfaces for servicing; and,
- Train "station" issues e.g. water filling, ability to use emergency coupler in platform road.

Next:

- Understand what is available in the market – aim to get proven design and confirm it really is proven and that the client is not being used as a guinea pig for the next stage of product development. For example, TPE based the Class 185 on Class 180 below the solebar and Class 360 above. Is there an opportunity to jump on the back of an existing and running production line? As this can save ramp-up time and costs.
- How innovative should you be? - Southeastern's Javelin for example was very high performing but not considered as very innovative (it used 1980s/90s traction technology that had been proven before) – there is a line to be drawn between innovation, such that your customers really see this as a new train, and being reliable out of the box.
    -
- Understand best practice - industry codes of practice – don't be afraid to challenge outdated or non-relevant standards (and allow time in the project plan to achieve necessary derogations).
- Understand your functional needs e.g. how passengers, crew, maintenance staff and other stock will "interface" with the new train – get robust input from operations colleagues within the TOC as well as engineers. *For instance, take the train specification detail down to the level of the sequence a driver or guard must go through to open and close doors (including SDO). Does this fit with station dwell times? How does the train's diagnostic system report faults to the driver? What does it tell them to do? How long will it take them to do it? Is the remote downloading capability sufficient?* Everything you decide after you contract could cost you money, and compatibility with other stock in your operation may be critical.
- Specify 'no single point failures' and don't just consider the systems but the train as a whole. I.e. Class 700 units introduced on Thameslink are 8/12 car fixed-formation units, which meant that a single damaged window can take the unit out of service. Is there the ability to isolate or makesafe such failures to allow that unit to complete its journey?
- Be clear on requirements from the data management systems on the train, including data formats and the means of downloading the information.
- Ensure you have the right to participate in the final design reviews. This will be an opportunity to clarify any grey areas left in the specification (see Section 13.3 below).

13.1.3 **Commercial strategy**

Recommendations from experience are:

- Start with at least 5 train suppliers and run with at least 2 – get to at least Train Spec and Heads of Terms Agreements with both, so you could genuinely proceed to contract with either. This is to maintain competitive pressure, and mitigate the risks of going to Preferred Bidder too early (e.g. rash promises can be slipped out of, it is more difficult to return to the non-preferred). Keep two suppliers in, so that you have a credible alternative right up to the point where you go for contract with one of them. Consider the manufacturer's order book too – success can breed success, but can also stretch the supplier's resources at critical points in your project.
- Decide whether you want to manage procurement yourself or get someone to do it – and if someone else does it, how much control you wish to retain. Can you afford to buy the trains yourself and then go for re-financing?
- Then, if appropriate, approach 5 financiers and develop 2. Decide between different forms of relationship.

Examples: ROSCO and TOC speak with one voice to the supplier, with a clearer focus on reliability and other essential requirements as a result.
In the South West Trains Desiro project, the TOC was contracted to manage ROSCO's interests in the procurement process on the ROSCO's behalf. For the Southern Electrostar programme a TOC/ ROSCO joint team was formed, where the ROSCO engineer was contractually designated as the TOC engineer's assistant. Both arrangements require individuals to develop good working relationships, and rely on being able to establish clear and acceptable contracts.

13.1.4 **Maintenance Strategy**

- Decide what you are buying e.g. Train and Spares only/ Train and Specialist Support/ Design-BuildMaintain/ Train-Service-Provider/ Availability contract
- Maintenance agreements can be thought of as 7-year costs (franchise term) and whole-life costs, to a TOC and a ROSCO they have different emphasis. Over the whole life of the vehicle they are such a small percentage that it pays for itself, spares are critical in later life. After spending a longer time with fleet, the operators team gain a greater knowledge of the vehicles, the same can be said for new builds of an existing platform – Electrostars are a good example of this.
- Agree delivery incentives (more details are offered in later sections)
- Set targets for overhaul cycles and routine maintenance periodicities, as these will be key drivers of both maintenance costs and train availability
- Be aware that a whole life maintenance plan may not be available at this stage. Great care must therefore be taken at later stages to ensure that the subsequent development of the plan does not present additional risks.
- If an aftersales division of the supplier is providing any of the services, what is their relationship with the manufacturing arm, and how committed is the latter to supporting the former? Is there an internal contract in place? How high in the supplier's management structure do decisions on cross-division support get made?

Example: Be wary of the split of responsibilities between operators and suppliers.
Siemens are responsible for all maintenance of the 700s at both Three Bridges and Hornsey, the existing arrangement at Hornsey had GTR drivers who managed wash and moving trains. Three bridges copied this approach and had Siemens maintaining trains but reliant on GTR for movements and the wash side – GTR had to recruit new drivers and management team for Three Bridges.
This was a missed opportunity for ease of working at the contracting stages. Both parties are working around problems but very strict contract makes it difficult Handover from maintainers to drivers for example is very prescriptive.

13.1.5 **Procurement process**

- Develop a risk allocation matrix – who is responsible for what.
- Plan your support services – make sure you have allocated enough good resources throughout the project and that they have the right knowledge and incentives – the person who reviews the bids should be the person who has to live with the product. This includes the operators e.g. ensuring the Driver Manager and Head of Guards sign off the specification.

From considering the primary roles of TOC, manufacturer and financier, roles of other players can be inferred and two key ones are listed below. (The TOC may of course choose to arrange with other players such as catering contractors to deliver aspects of their service.)

13.1.6 **Role of the Franchising Authority**

- If new train procurement is a requirement in a franchise, then enough time should be allowed prior to implementation to enable a robust procurement process to be set up and delivered.
- Timely core specification policy decisions should be made to set the framework and key interfaces (using the criteria set out e.g. extent of compatibility with other stock), to enable the TOC to do the detailed work (and iterate with the franchisor on some of the core requirements, if they appear unduly costly).

Example: What is specified may be found at a later stage to be unfeasible or undeliverable.
Connected Driver Advisory System (C-DAS) was specified by the DfT for the Class 700 but had no details of what C-DAS was to include. Siemens fitted a generic solution that 'should' marry up with the Hitachi Traffic Management at Three Bridges ROC but currently unknown if it will.
Both Greater Anglia and Northern found themselves in a similar situation with "ETCS-Ready", which DfT has specified within the requirements with no formal definition of what that is.

13.1.7 **Role of the Infrastructure Manager (Commonly Network Rail)**

- Work with Network Rail and other operators on station design and increasing platform lengths etc. Siemens worked with Network Rail on station designs throughout the Thameslink core to ensure that dwell times could be met, this included signage to optimise flow from doors through barriers and onward in passenger's journeys.
- Thought should also be given to specifying and buying space or land for depots and stabling etc. Is the land available, possible that it is earmarked for other projects or public sale?
- We also need to work with Network Rail on plans for electrification, how likely are these to remain on schedule and be delivered? This can greatly affect your choice of traction type, with bi-mode offering security in the short term until the electrification is complete.
- Following on from electrification plans; specifications for overhead lines and 3rd rail parameters and interfaces with the train need to be considered, as the actual infrastructure can vary from Network Rail's drawings.

13.2 **The Contract – (Ensure you get what you asked for)**

This section is grouped into two parts: one around delivery (what you get) and the other around finance and train performance (how you pay for what you get and protect yourself from not getting it).

Before we jump into it, it's worth discussing some of the cultural differences you may encounter. There can be a cultural disconnect between commercial and engineering departments in different countries companies, which is often of benefit. However, there can also be a disconnect between project delivery teams and design teams in organisations set up with individual business units which must work together on new train introductions. This is a problem when technical experts are in a different country.

13.2.1 **Firstly, some recommendations around acceptance and delivery**

- Delivery profile is crucial – TOCs should be comprehensive in requiring delivery gateways. For instance:
    - if some payment milestones are spread through the design and manufacturing phase, chose “hard evidence” gateways (e.g. first article inspections, submission of type test reports); rather than ethereal ones (e.g. the supplier’s internal “design freezes” or assembly line “build stages”, which can be passed with issues outstanding)
    - treat “hard” deliverables (e.g. special tools, initial spares stocks) and “soft” ones (e.g. technical libraries) with equal weight, and specify when (how long in advance of train delivery) they should be provided to unlock train acceptance
    - use Qualified Acceptance to incentivise the supplier to close out acceptance issues. This should, ideally, be linked to a price retention.
- Detail is critical e.g. if you’re looking at a proven product, explicitly require the defined performance levels achieved on other railways – and be clear about when they’re required and what happens if they are (or are not) achieved.
- Particularly if the rolling stock being procured is of a substantially new design, time should ideally be allowed for evaluation of the first trains built before full fleet delivery takes place. For example, TPE gave drivers pre-handover time (say 2 weeks) on the trains to test fault scenarios and “see if they can break it”, to enable design tweaks and process changes to be made.
- Getting to the position where the supplier’s aftersales organisation is treated by the manufacturing arm as an internal customer in parallel with the TOC as external customer, should be the goal when setting up the acceptance process.

13.2.2 **Technical documentation and data**

- Be specific about technical and user documentation in the contract – flesh out what you mean by “all documents required to enable efficient and safe maintenance and operation”. This might be by requiring an explanation of why each element of the maintenance plan is there, and an outline of the limits on periodicity of individual activities and what risks they were designed to mitigate. Such an explanation would boost understanding of how to improve initial reliability and provide a robust basis for developing and refining the maintenance plan going forward. A specific milestone of maintenance plan delivery on physical media such as a read only memory stick is recommended – experience with too easy to change web-based interactive manuals is often bitter and can conflict with basic principles of document control.
- Be clear about how you want the information to be delivered – does a bundle of A4 photocopies with suppliers’ part numbers on constitute a list of parts? What interfaces are you looking for to integrate with your existing maintenance management systems? Similarly require definitive delivery of special tools e.g. laptop-based diagnostic software at an appropriate milestone.
- Have the short and long term end users of the documentation agree the format. These users may be ROSCOs, TOCs, and the supplier’s own after sales division.
- Require Safety Critical components to be identified for your approval as safety critical, so that the requirements of best practice can be met e.g. ATOC/ACOP/ EC01003 Supplier Accreditation (soon to be superseded by RIS 2750) and ATOC/ACOP/EC01007 Management of Safety Critical Components (which recommends for example that Safety Critical components are also entered on PADS).
- Either:

    - formally review and approve or;
    - require sight of maintenance and overhaul instructions particularly of components, because TOCs as Railway Undertakings need to know – to ensure they are credible and compatible with the maintainer's facilities.
- Ensure you have access rights to all data within the Train Management System, and all off-train software needed to analyse it (contracts have varied, even between TOCs buying the same train, and lack of information can hinder reliability growth).

13.2.3 **Supply Chain Management**

Change control is particularly critical. Be guided by your assessment of fundamental risks and use a standard engineering change process. There have been instances in long build contracts where inferior components have been substituted without reference to the TOC. Of course, some changes are necessary and/ or desirable as better products are developed or existing parts become obsolete: there should be a contractual clause to the effect that TOC agreement would not be unreasonably withheld. The TOC should also contractualise the right of audit of supply without warning, but be sure in the contract (and within company processes and safety case) that this is not used to weaken the supplier's product responsibilities. 13.2.4 **Obsolescence Management**
This is a growing concern where we have undertaken some benchmarking with other industries who also have long-lived complex products e.g. Westland helicopters. See Section 12.6 above, which recommends that obsolescence risks are identified for every train and a conscious decision is taken about how to manage each one. This may include additional specific contractual requirements or responsibilities extending beyond the warranty phase, possibly into long term management deals.

An important question to ask at the early stages of design is have the bid team left flexibility in their design and requirements? This is more of a concern for future franchises or the rolling stock owners as they may be restricted in later cascades or route changes if there is no future proofing. I.e. are you procuring a diesel fleet when electrification is a possibility in 10 years' time – perhaps a bi-mode traction type will provide greater felicity in future use, even if the electrification never arrives.

A Design Authority or similar support arrangement should be in place for each fleet, to provide a point of reference for design information and knowledge, and a base from which electronic systems and the vehicle in general can be developed throughout its life i.e. proactive obsolescence management. It will certainly include some careful thought about electronics and software – such as considering requiring life time buys for some electronics and clear software escrow rights in general.

New trains' electronics have shorter product life cycles, therefore an increased obsolescence risk. Electronics are not always expected to last the life of the train. This needs managing, on the basis that the train needs to continue functioning. Obsolescence is also compounded by new trains being built from a 'kit of parts'. Component drawings and design knowledge may be held at sub-supplier level and not in the public domain, making it harder to resolve future issues. Don't hesitate to challenge existing designs of systems where appropriate and insist on a new approach or way of thinking.

13.3 **Secondly, some financial recommendations**, (linked to train performance and delivery)

13.3.1 **Performance**

- Insert a heavy dose of realism into the numbers discussed. By all means, set an aggressive figure, but base pre-contract supplier assessment on what they have achieved on fleets with

similar technology and what they are going to do differently to get the figure that the TOC's business case really needs. If the negative impact on the service is marginal, then contracting for a higher reliability figure in a time that has never been achieved is likely to end in disappointment and be sub-optimal in cost (i.e. we will be paying much more money for marginal benefit – compared with spending it on infrastructure for example, and assuming that the supplier does channel the money into improved designs and does not simply build in a higher performance penalty contingency). The best way of getting to this level is to be rigorous, but allow time. Realistic requirements for a fleet might be 18 million miles running (which could equate to 9-18 months elapsed time, depending on fleet size and duty cycles).

- Use standard industry measures (3 Minute Delays [MTINs], delay minutes) as the indicators in your performance regime. Do not allow the suppliers to quote their own measures such as 'technical capability' which favour their statistics at the expense of your passengers! Also, be wary of using older performance measure, i.e. *DfT specified reliability for the Class 700 using MPC (miles per Casualty).*

- Ensure the supplier takes responsibility for problems caused by poor design of ergonomics and

the man/machine interface (e.g. misleading messages on the train's data management system).

- Include targets and incentives for reliability of passenger amenities (toilets, air conditioning etc.).

Example: Depending on what you are contracting the manufacturer for, synergies can be made between certain requirements and targets.
With the Class 700, the DfT had specified for both optimised maintainability and reliability, and reducing energy consumption – in fact the lighter the train was, the more they were paid. However, Siemens had to make sure that any savings in weight were not detrimental to maintainability or reliability (lighter yet solid). This is a benefit of the train builder and the Maintainer being the same entity, rather than making the train lighter at the cost of reliability.

- Ensure that warranties and financial incentives are clear. Set realistic and enforceable delivery targets e.g. to achieve half the eventual reliability performance on Day 1 - otherwise you won't buy the first train; unless MTIN of x achieved by day y – you will stop buying, or pay a cheaper price (i.e. link performance to price). Don't rely on the service organisation to get back to the manufacturer on a "with maintenance" deal. Service organisations will always cap out their warranties on performance – retain a performance warranty with the manufacturer in addition.
- Set out in Warranty the following terms: what you get; what the supplier does; what you do. There should also be a strong endemic defect clause such that if you reasonably believe you're getting a defective product, you can choose to stop buying until the issue is resolved – without having to reach a threshold of failures first.
- Set up a retention bond - available to put right a major system failure should it happen even after you've bought the trains (beyond warranty and for the things you don't yet know about). Of course, this risk is reduced the more you can buy a proven product.
- Seek timed and priced options for flexibility e.g. to cope with future growth (inserting extra vehicles in a rake) or possible changes in future usage.

13.3.2 **Payment profile**

The ROSCO has a significant role in the payment profile and this profile can have a significant impact on long term reliability. Bear in mind the risk of conflict between TOC and ROSCO requirements – the ROSCO wants to get a train which someone is paying rent on and which will be leasable throughout its life; the TOC wants to get a reliable train which works and meets its franchise requirements. This points out the need to develop a good relationship with your ROSCO, backed up by aligning interests contractually as far as possible:

- Ensure there are robust incentives on the manufacturer to close out all the technical issues – bonds and retentions are much more powerful in this respect than warranty agreements.
- Consider how Qualified Acceptance could work to incentivise the supplier and financier. If the financier withholds a proportion of payment until qualifications are removed from an Acceptance Certificate, then lease payments should be reduced commensurate with this.
- Require unrestricted access to manufacturing as part of a robust acceptance process, to satisfy yourself that each acceptance gateway has been achieved and the project (and payment) can proceed. It's also good to link payments to the formal Approvals milestones i.e. work closely with your Notified Body (NoBo) to define and link these. It is less desirable to link to the manufacturer's own design process because this does not have a direct relationship with your milestones.
- Require pricing transparency on any variation order from the supplier to check it is fair and that they have not made an error (examples of simple errors found include over-stating the number of units required to be modified; double-counting for overheads – both in the artisan rate, and added separately; including the original base design costs in addition to the costs of the actual variation). In some cases, such errors have doubled the quoted cost of the variation.

ROSCO choice may be affected by attitude taken to variations after contract, for example their treatment of TOC-led reliability improvement changes e.g. to make the doors work better (which are relevant to the whole life of the train). Other factors include willingness to allocate an agreed lump sum up front for getting things right (i.e. to help make beneficial changes). Capital sums for these and other things (e.g. depot improvement) should be available at a reasonable rate.

13.4 **The Design – How the product works**

This section starts from the functional specification drawn up by the TOC at the Invitation to Tender stage.

At this point the suppliers bid team should hand over to the production team or even integrate with them to maintain knowledge of bid commitments.

13.4.1 **Functional Specification**

This should identify issues that are important to your operation which might not otherwise be recognised, such as:

- Splitting and joining and moving away needs to be achieved reliably (quantify) and within x minutes,
- Times for door opening and closing sequences; time to shut down, change ends and open the desk; Drivers' prep time (affects trade union agreements as well as train timing) – what is

your performance specification for these timings, no worse than today or an improvement above that?

- Coping with short platforms (Selective Door Opening requirements) and Driver Only Operation,
- Any safety/ compatibility management requirements that might be passed to the TOC by the supplier. For example, requiring electrical interference monitors or other safety systems to be checked daily. This can require attendance of technical personnel at locations such as stabling sidings where they would not normally be present. This adds cost and stretches resources,
- Maintenance constraints and opportunities which the train should be designed around (e.g. that no components of the train should require planned maintenance intervention between the maintenance intervals you need for diagrams),
- For electric trains, ensure the train can be re-started easily after a 3rd rail or Overhead Contact Line supply outage,
- Ease of access to equipment required for in-service diagnostics and fault mitigation (e.g. not putting re-settable or diagnostic devices in cupboards a long way from the driver or adjacent to high voltages),
- Mechanical and electrical compatibility with existing fleets that the TOC will continue to operate,

This is crucial to successful operation in the real railway and to effective mitigation of any defects in service – the TOC must remember that it knows how trains actually operate and translate this information into design requirements. Never assume that the supplier has operational knowledge of their own products.

There needs to be involvement from ASLEF and driver representatives on cab design early in the process. Use ASLEF's good practice guide and RDG's Guidance Note for further assistance.

13.4.2 **Design review**

- Check the comprehensive technical specification you have requested from the manufacturer against your functional requirements; go and ride on existing products that are being touted as proven experience (and talk to the people who are using, operating and maintaining them). Get familiar with the design – require a document that describes how the door control system works, then meet the suppliers' engineers and check your understanding.
- Take care not to acquire design responsibility – write everything down scrupulously to document what exactly you have agreed to (e.g. that you said option A appeared better than option B – this

  is NOT tantamount to absolving the supplier of their responsibility with respect to option A, and does not alter the reliability requirements in the contract).
- Design freeze and standards freeze – be clear about when exactly this should be, and what exactly this is, so that there is a shared understanding of change flexibility before (and rigidity afterwards).
- Standards conformance – be clear whether any non-conformity or derogation from mandatory standards is required, who is responsible for getting it and determining what is acceptable as an alternative.

- Change control – when you agree a change at whatever level, clarify in writing – and keep all correspondence. Do not absolve the supplier from their obligation to provide a compliant and fit for purpose product.
- Concentrate on interfaces – with the infrastructure, the train crew, the passenger, the maintainer, other trains. Focus on software functionality.
- Focus effort on the biggest risks to reliability, feeding in to the design of the Train Management System and its interfaces to driver and maintainer. Look at the top 10 on your existing fleets and other fleets like the trains you're buying, and require the maximum data from the train for these areas. For example, doors: emphasise your requirements for door functional information capture, identifying incipient failures, diagnosing root causes of faults, especially intermittent ones.
- Build in redundancy for particularly critical systems where it will bring you reliability benefits that are worth having (e.g. compressors)
- Design risk can be covered off at the performance level, but if you are buying a train and doing your own maintenance then design changes during the build may have significant downstream costs for the maintainer (e.g. a fleet with a mixture of different types of repairable component under the same part number, may require different maintenance specs - cost and effort which could have been avoided if there was a clear requirement not to make any design change (even at a low level which doesn't impinge on the functional spec) without client approval. One TOC found that employing 2-3 people to monitor this proved worthwhile in terms of downstream costs avoided.

13.4.3 **Type tests**

The type tests of specific critical systems should be witnessed or at least reviewed, to gain assurance of their validity in terms of the functional specification for this particular TOC application. Insist on agreeing the specification of the type test, especially for systems where operational context is a factor e.g. doors.

13.5 **Manufacturing – Making sure it works**

13.5.1 **Theory – desktop information**

The TOC should follow through from type approval to gain comfort that the production roll-out is robust, seeking specific information to review as part of assurance that work is progressing (and tied into payment and progress gateways). The TOC should have access to all drawings and build data, and be able to review assembly processes. The TOC should have access to all stages of manufacture (at critical system OEMs as well as the main supplier, where relevant) and to view the consistency of production and manufacturing standards. Contracts should allow access to sub-suppliers, where necessary.

Take advantage of First Article Inspections, which are a formal method of providing a reported measurement for a given manufacturing process, to create more direct lines of communication, especially when doing in-house maintenance rather than through a supplier contract.

Equally, the TOC should take an interest in the supplier specifying engineering standards, and having a robust staff training and competency management system. Other relevant supplier systems include their goods inwards inspection and their configuration database.

13.5.2 **Practical - on-site presence**

Provided that responsibility for production is not confused, it is generally worth having a customer presence in the supplier's factory.

> Example: Southern found that having 2 TOC engineers in Bombardier's factory and 1 at their commissioning depot was worthwhile - in terms of the identifying and resolving issues which could have started to cause problems in 10 years' time.

TOC engineers on site in supplier (and, where appropriate, sub-supplier) factories have often facilitated communications on the latest issues. This minimises the number of vehicles which continue to be built with a defect once it has been identified in service, hence saving rectification work and benefiting all parties.

> Example: There is a risk that train builders are tempted to overlook manufacturing problems arising during construction as they believe the TOC will not see or be aware of the problems – such problems might only come to the surface some years later during overhaul or when exchange components do not fit. Reported cases include anti-corrosion treatments, paint quality, and dimensional build tolerances.

Mistakes will be costlier later unless they are addressed early. Although mistakes cannot be planned for, risk analysis should be conducted to identify potential failures and delays to the plan.

> Example: SWT (who were also explicitly acting for Angel) found that assembly line audits were useful for residual value issues associated with passenger environment and paint quality.

Working with the supplier's service organisation can also help raise build quality which has a whole life benefit. Many TOCs undertake factory gate commissioning, requiring TOC acceptance to be achieved before vehicles leave the factory. This is in addition to commissioning on site in the nominated UK maintenance depot.

Resident Engineering rights need to be built in from the start, including requiring an office in the manufacturer's assembly factory.

13.6 **The Acceptance Process** – (Does the whole train work)

This document does not cover the safety-focused approvals process (with Notified Bodies etc.); we just deal with customer acceptance, focused on reliability performance.

The kind of gateways which TOCs should set are:

- **Preliminary acceptance** at factory gate (i.e. before each vehicle leaves the factory, after say 1000 miles of fault free test track running). The mileage can only be gained after leaving the factory but before the TOC accepts the train.
- **Commissioning**, both static and dynamic tests to gain enough confidence for trains to be run on Network Rail controlled infrastructure on test runs, accumulating mileage and proving experience. This phase enables the ambience to be assessed (e.g. noise, ride and comfort, in addition to finish and décor).
  The examination work associated with commissioning should be regarded as the "Zero Miles" exam in the Maintenance Plan. It is vital to subsequent safety and performance that it:

- Contains every task required to permit the vehicles to run to the next scheduled examination and hence to the longest scheduled maintenance interval in accordance with

  the safety certificate.
- Is performed only by people who possess demonstrable competence in applying maintenance plan tasks. That is the supplier or sub-supplier responsible for this should be competent and sufficiently skilled to carry out the work to the required level.

- **Provisional acceptance**, after which trains are fit to run in passenger service, under the TOC's Safety Certificate (this is usually a static test, after say 15k miles trial running on Network Rail controlled infrastructure, supported by an engineer on the first day in passenger service). This 'shakedown' testing should look to mimic their future operations and diagrams on home routes i.e. copying frequency of stopping, door opening, turn-around times etc. At this stage the trains are technically procured (i.e. ownership transfers from the manufacturer to the financier) – but the job isn't finished…
- **Final acceptance**, 2 or 3 years on, when each unit has had all the latest mods retrofitted and software versions upgraded; plus, say 20k miles of fault-free running and 3k miles of no system faults; plus, all the correspondence between TOC and Supplier has been closed out.

Ensure passenger amenities are given suitable importance, both in the supplier's test programmes and in your own acceptance checks.

To facilitate acceptance, the TOC should have unfettered access to finished units, this should be clarified in the form of site facilities and what arrangements are made for TOC personnel on site.

Doing Engineering Change (EC) before type approval has risk of differing away from scope – the operator has less control but also less work for processing additional ECs. There needs to be a protocol to come from final design review regarding type approval and commissioning to ensure that the product has not drifted from what was initially promised.

Note on test tracks – they are invaluable for getting past first base in developing the technical safety case for a new train, and for validating later changes to the design. Pre-delivery endurance running on test tracks is useful as a sophisticated build quality check, but a true indication of reliability only emerges from experience on real infrastructure, which tends to draw out many more issues. It would, however, facilitate acceptance if Network Rail would more readily agree to testing proceeding on a particular track between particular times rather than having to set up a signal protection zone.

UK test tracks are in high demand and thus often unavailable due to other activity or installation, upgrade of equipment between testing. It is possible to do some testing abroad but it is difficult to replicate UK trackside to a sufficient standard (mainly due to inconsistencies between our own implementations across routes.

Methods of testing and introductions vary between existing schemes with current trains and new and unused schemes – i.e. Thameslink vs Crossrail. Testing also varies depending on whether they are a First in platform or class of train or a developed production line with a proven platform (i.e. Bombardiers Electrostars vs Aventras).

At the provisional acceptance stage, trains will start to be delivered to the operator. Too often the operator is left to deal with the units once they leave the factory, where will they be stored, depot changes needed, and handling the influx of extra trains on top of the existing fleet, these are often out of scope to the supplier, so it is worth giving this some thought beforehand. There are two types of introduction:

- Phased fleet introduction - One strategy is to gradually replace old trains with new, perhaps even while improving old rolling stock, such as Eurostars' example introducing the new e320 while overhauling the e300s to match. This is particularly common with partial fleet renewals.
- Alternatively, a more aggressive approach can be taken. Full fleet introduction is often taken under franchise commitments to replace the TOCs entire fleet with new trains and must meet a set date under the commitment, such as Greater Anglia's complete fleet renewal by 2019.

You should try to combine operations testing with performance building time to start "out-of-the-box" with higher reliability. Use time efficiently, trains are used between 18 and 20 hours a day, training can't happen all the time; forward planning will be needed to allow service to continue whilst training happens. As well as this we should allow for testing runs and promotional activities.

13.7 **Service Introduction** – (How well does it work)

Some initial points of note:

- Be sensible with unit introductions: use low mileage return to depot diagrams. Siemens were forced into GTR's existing diagrams and timetable, rather than optimising a diagram for testing etc. They were running 800 – 2000 miles and 2-3 days before returning to depot. Instead aim for less than a day in service before returning to depot, such as post morning peak etc.

- Have strong contingency plans, Defective On-Train Equipment (DOTE) policy should stay with TOC as supplier cannot influence their 'cut and run' policy.

13.7.1 **Interface with Operations**

It should be noted that the challenge here is to integrate the new train into the Railway Undertaking's Safety Certificate. There is a significant amount of work which has often been underestimated e.g. training additional drivers (both because TOCs need more drivers available so they can free some up to be trained on the new trains – and for driving the test runs on the new trains). This might imply a 5 or 10% increase in drivers required for a period approaching full service introduction.

Of course, many other resources are affected, not just drivers. For example, the new train introduction may extend over years, so that the fleet organisation might need to change teams to support day-to-day production management and facilitate the necessary changes in the production environment. Vehicle mileages should be managed across the fleets to prevent workload waves which put availability at risk. Overhauls should be anticipated e.g. preparing specs, deploying spares floats, developing capacity and competence at overhaulers.

It would be wise for the Franchising Authority to ask some searching questions where franchisees propose new trains to ensure that they have sufficiently robust plans for increased resources to optimise service introduction.

There can be a disconnect between a projects delivery team and the next projects commissioning team – lessons don't carry across and there's no feedback into the build line. Thus, it can be worthwhile to establish contact with other operators who are currently introducing the same platform of train; what has their experience been like, are there any lessons that can be implemented in this order to improve reliability later. Fleet user groups and cross industry stakeholder groups are also seen as good resource within the programme, however there are less of them for new build trains.

Operators should be realistic about the rate of change and ensure that they are communicating with the rest of the company. This could take the form of continuous readiness updates and briefings to carry staff with you through the business change. How are the rest of staff affected?; does their rostering have to change whilst training takes place, what level of knowledge of the new fleet – and its differences with the current trains - do they need to continue to do their job.

Within engineering, consider how to brief common faults to staff and any procedural changes that arise from them, are their existing ways of working or lines of communication to use? Can staff who will use the supplier's documents understand them – review Vehicle Maintenance Instructions (VMI) with technicians etc. Likewise, we can use driver trainers and standards managers to review procedure manuals.

13.7.2 **Interface with Manufacturer**

This is particularly critical if the TOC is taking over the maintenance of the trains, as responsibility shifts.

Example: You should take care not to jeopardise warranties e.g. by altering usage of door release antitamper catches, effectively requiring components to deliver more than their designed capacity.

Similarly, if the TOC has a service provision or maintenance contract with the supplier, the TOC is in a good position to strengthen the arm of the service provider/ maintainer in resolving build issues and ensuring timely modifications programmes are delivered by the suppler.

Also, consider the period that the suppliers support will be available, if they are doing maintenance for at least the first few years, they will have an interest to get maintenance documentation correct early on.

Depending on the precise contractual arrangements, issues such as spares provision and management should be followed through – and above all, there should be regular contract meetings around all the emergent issues and the delivery of resolutions to them.

Example: A TOC should aim to ensure all emerging issues are openly discussed and resolutions identified between the parties before expiry of the relevant warranty period.

Operators should beware; gone are the days of a commissioning team of 3-4 people who know all the ins and outs of the train, instead we have teams or even departments of 30+ people who specialise in each sub-system and their boundary of scope. This means that very few people in the manufacturers company have an appreciation for the 'big-picture' and that when there is a technical problem manifesting across several systems, the diagnosis and corrective action could take much longer. Often, if the local support within the operator cannot find the fault, that component may be sent back to the manufacturers homecountry where their specialists are based.

Example: Avoid training that is delivered from a sub-systems OEM point-of-view as this doesn't give maintainers the 'big-picture' of how systems can work together and influence behavior.
Siemens took this approach with the Class 700 and then introduced a 'wiki' resource for maintenance staff to act as a repository of knowledge, including; common faults encountered, previous fixes, and how systems work etc. Staff are incentivised to contribute by adding money to staff entertainment fund.

Ask for groups of specialists knowledgeable in the trains and systems during introduction that are on-call 24/7.

13.7.3 **Interface with Network Rail**

Key to minimising the pain of service introduction is to ensure that Network Rail appoints a Project Manager to pull together their inputs. TOCs should meet with them once a week to work round any emerging problems e.g. booking test slots. TOCs should ensure that they establish compatibility on all the route sections and tracks that they might wish to run a train on, either as a timetabled or exceptional move, and that Statements of Compatibility are published for all those possible moves. This should be closed out by updating the Sectional Appendix.

13.8 **Reliability Growth – Delivery to the passenger**

Many of the issues highlighted in this section are cited as best practice for existing fleets in other parts of the 20-point plan. However, it may be worth drawing attention to the particularly critical nature of some of the issues at this stage of a train's life.

13.8.1 **Design for maintenance early on**

As with the above discussion on how innovative should you be, it is worth considering your level of dependency on software. Different systems can require updates at differing intervals based on that suppliers' development, different laptops or maintenance tools to interface with, and different skill sets for fault finding and general maintenance. Eurostars' e320 on the other hand, still has a lot of train wires hard wired rather than using a data bus to the Train Management System (TMS) - equally, hard wired solutions can limit your scope for future expansion.

Software can present unique issues, there is often no understanding of how it fails, how to fix it, or the impact that might have. Operators need to trust that the developer or competent person within manufacturer can help you understand and mitigate negative effects.

With mechanical systems, we can audit and follow procedures of mechanical fixes however software and discreet electrical components don't allow for this. With software and discreet electronics, we need to know:

- What's the test procedure?
- What's found and led to that failure mode?
- Once a fix is developed and bench tested, it needs a robust test regime before it goes out into traffic;
- This should be auditable between ROSCO, TOC, Train OEM and System/component OEM.

Note that suppliers can get caught up demonstrating that their specific kit works to "pass-blame" to other interfaces and sub-systems, proving a false positive. This builds on the common problem of fixing the fault and not the root cause.

The operator or manufacturer need a robust test regime after implementation of fix to monitor success. Software updates (previous and current version) should be held in ESCRO until updates are made and proven successful to protect from suppliers leaving the market.

Cash flow must go back into improvements. Compensation payments can focus suppliers; another solution is to stop accepting new builds until they sort it – so long as this does not impact franchise commitment dates and targets. Once payments stop suppliers lose interest and move on to next project.

Performance regime will specify the need for support team to be there, and this shouldn't be hard-coded into fixed time periods, instead make it a steady state to be reached.

13.8.2 **Measure everything – and follow it through**

TOCs should not underestimate the resource needed to monitor what's happening sufficiently effectively to be able to identify and resolve root causes of unreliability. Effort is also required to develop efficient mitigations (e.g. switches the driver can reset, work-rounds) to reduce the impact of faults while root cause solutions are being developed and implemented. Work closely with traincrew, as they will be the first to see problems, but build their confidence by giving them feedback on how problems are being tackled and overcome.

There should be engineering support for the maintenance and operations controllers e.g. a technician from the train manufacturer to sit next to them in control. This technician could then download and interpret the information that ought to be available from modern rolling stock, such as remote downloads on critical system behaviour in detail for the past 5 minutes from the Train Management System.

A maintenance team should be committed to monitor pre-faults (not just faults) to make the most of the information downloads which should be available (from OTMR, TMS, condition monitoring on specific systems). Even if the TOC continues to be responsible for maintenance, the maintenance organisation will need to be rejigged to suit the new trains – and to make full use of the likely step change in volume and quality of real facts available for analysis and downloadable remotely.

Manufacturers may need to be reminded that the TOC is accountable for operational safety on Network Rail controlled infrastructure: once trains have been delivered, the supplier must consult the TOC prior to any modification, operational mitigation or change to maintenance activities, irrespective of the contractual position in financial terms.

Exploit the data from the train data systems and ensure it is made fully and freely available. It is your data, about your trains, after all! Avoid being charged by the supplier for collecting or processing information, and use the opportunity to overcome any difficulties with downloading, transmitting or formatting the data.

Example: Ensure that you have access to RCM data even if the manufacturer oversees maintenance. On some of their older trains, Greater Anglia have integrated their RCM with operations & engineering which allows them to monitor the systems and look at events from both disciplines points of view. This is very useful & enables joint investigations etc. With the new trains that they are getting, they won't necessarily get access to the RCM data, so doing this sort of activity may become impossible or not so easy / joined up (i.e. if the different departments use different systems to monitor what is going on).

Again, make sure that passenger amenities such as toilets, information systems, catering equipment and air-conditioning are given sufficient attention at this stage of the project. Recent experience suggests these are often the hardest items on the train to get right. It is particularly important to involve operational staff, and ensure defect reporting systems are working smoothly in this area.

13.8.3 **Manage the interfaces**

Joint forums should be set up to discuss and analyse experience and to own the development and deployment of improvements. Relationship building and attention to detail are critical. The manufacturer should be incentivised to design out problems (perhaps facilitated by some of the monies established upfront at the contract stage).

Other technical issues to watch for (and feedback to future functional specifications) include: operational peculiarities that may not have been accounted for in the original functional specification, such as the impact on particular systems of commuter trains being stabled over more than 24 hours, say on Bank Holidays, e.g. with compressors shut down over this period - the pressure leaks off, electric coupling heads open up, generating a range of fault codes which lead a driver to declare a failure when they comes to take the train on the Tuesday morning.

13.8.4 **Consolidation**

As the service beds in, opportunities to hone the maintenance regime in the light of experience should be identified and exploited to drive costs down – particularly through using predictive tools and making the most of remotely downloaded data. If there is still room for improvement in performance, the TOC and the supplier should build a Reliability Growth Plan with specific actions to take the project forward and get to where everyone wants to be!