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Clive Kessell’s recent articles reviewing the Manchester South domestic suppliers. Unlike their colleagues in other European railways, they believed British railway managers and engineers had a unique attribute.

The cynical answer is that we cannot. Over 40 years in the industry tells me that railway engineers’ blind belief in the superiority of foreign technology is probably genetic.

Of course, the counter argument is that a state subsidised railway owes it to the taxpayer to provide the very best and most economic systems and equipment, which means buying world class technology wherever it comes from. But signalling procurement policy shows the bankruptcy of this rationale when combined with uncritical acceptance which equates ‘different’ with ‘superior’.

This is not an appeal for protectionism in the home market.

When something demonstrably better is available it should be bought – although even then the national economic interest should demand off-set manufacture. But, in future, the supply industry should have, at the least, a level playing field, with a presumption that any challengers to equipment in service should demonstrate genuine superiority – and the demonstration should not be at the customer’s cost.

Or, as a manufacturer once put it to me, ‘we shouldn’t have to be better to be equal’.

Roger Ford Comp IRSE
The Use and Misuse of SIL

by Roger Short CEng, MIRSE, MIET
Atkins Rail, UK

Presented in London on 14 January 2009

HISTORY OF SIL

The idea of a scale of levels against which to measure the safety characteristics of programmable electronic systems and their software emerged during the 1980s in the course of the development of international standards for such systems.

This led eventually to the production of IEC 61508 [Ref. 1], the generic international standard for programmable electronic safety-related systems which formed the pattern for the CENELEC standards for safety-related systems in railways [Refs. 2 and 3]. Whilst these techniques, many of which are still to be found among the recommendations of the standards, were clearly capable of reducing the probability of errors in software there was no way of predicting how many errors would remain in any software to which the techniques had been applied. It would thus not be possible to calculate the probability of unsafe failure for software in a way comparable to the calculation of the probability of failure of electronic hardware on the basis of data on component failure rates.

Although the science of software reliability was not, and still is not, able to predict the probability of errors in software with any degree of accuracy, the pioneers leading the way to the development of IEC 61508 did feel able to use expert judgement to rank the available techniques in order of their effectiveness in ensuring software correctness. Techniques for each stage of the software lifecycle were placed in one of four groups ranked in order of increasing effectiveness. Software could then be developed to achieve one of four levels of safety integrity by using techniques from the correspondingly ranked group at each stage of the software lifecycle.

The UK railway industry standard for safety related software for railway signalling published by the Railway Industry Association as RIA 23 in 1991 used the SIL concept in exactly this way. RIA 23 was in fact heavily indebted to IEC 61508 in spite of pre-dating its official publication, the group responsible for drafting RIA 23 having benefited from the advice of the UK members of the team whose work eventually resulted in IEC 61508. The RIA standard appeared well in advance of IEC 61508 because the latter was subject to the ponderous procedures necessary for an international standard to achieve consensus before publication.

In essence this is how software of a required SIL is produced today: suitable techniques are selected from each of the tables of recommended techniques in the standard, as indicated in Figure 1 below.

Figure 1: How to Claim SIL 4

The number of ways of selecting one technique from each of the tables in the standards is very large, estimated to be somewhere in the region of $3 \times 10^{16}$.

The principle of achieving levels of safety integrity according to the techniques used in system development was readily extended to cover protection against errors in design, installation and maintenance and other “systematic” errors in electronic systems. EN 50129 has ten tables of techniques, but unlike EN 50128, most of the techniques in its tables are not treated as alternatives. It is common for most of the techniques in each table to be used in the development of a safety-related system, so that in practice the number of combinations of techniques actually likely to be used is much lower than for EN 50128.

SIL AND PROBABILITY

At some point in the continuing development of the SIL concept it was decided to associate a numerical probability value with each SIL. Both IEC 61508 and EN 50129 [Ref. 5] now include a famous table relating SIL to dangerous failure rate, reproduced below as Table 1.

Careful reading of IEC 61508, EN 50128 and EN 50129 shows that the standards do not actually claim that by following their recommendations for each SIL for software the corresponding probabilities of dangerous failure will actually be achieved, but they are widely, if incorrectly, interpreted as saying this. The author has encountered this interpretation on numerous occasions when reviewing safety cases associated with major railway projects.

Table 1: SIL and Failure Probability in IEC 61508

<table>
<thead>
<tr>
<th>Safety Integrity Level</th>
<th>Probability of dangerous failure per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>$\geq 10^{-9}$ to $&lt; 10^{-8}$</td>
</tr>
<tr>
<td>3</td>
<td>$\geq 10^{-8}$ to $&lt; 10^{-7}$</td>
</tr>
<tr>
<td>2</td>
<td>$\geq 10^{-7}$ to $&lt; 10^{-6}$</td>
</tr>
<tr>
<td>1</td>
<td>$\geq 10^{-6}$ to $&lt; 10^{-5}$</td>
</tr>
</tbody>
</table>
This linking of each SIL to a specific value of probability is the main source of the anomalies and misuse that has grown around the SIL concept. The very claim that the application of any combination of techniques will achieve a probability of dangerous failure in the ranges associated with the higher SILs is itself a misuse of probability as normally interpreted in the quantification of safety and reliability. It is not clear how the probability values in Table 1 were arrived at, but it seems certain that they must have been based on expert judgement rather than empirical data. At the time no one can have had sufficient experience of the operation of a safety-related system developed according to the recommended techniques to know whether such failure rates had been achieved, and even today there is limited statistically significant data.

In order to demonstrate that a probability of dangerous failure of 10^{-6} per hour had been achieved it would be necessary to have something in the region of 10^{12} unit hours (that is ten thousand million hours, or about one million years) of operation free of dangerous failure. Even today very few safety-related systems can claim this amount of operational experience. The SSI Trackside Functional Module (TFM) was introduced in 1984 and over the subsequent 24 years the population of TFM has grown to something in the region of 30 000 worldwide, giving an estimated 3 \times 10^{10} unit hours of operation. There are a few other systems in the world with a comparable extent of experience, but even if the results of all of them were taken together they would not supply confirmation for more than a few of the SIL 4 combinations of techniques.

The credibility of aligning each SIL with a narrow band of probabilities is further undermined by this very large number of combinations of techniques which can be claimed as capable of achieving a given SIL. There are many thousands of ways of achieving SIL 4 software which all comply with IEC 61508, but do they all really result in a probability of dangerous failure within the range 10^{-8} to 10^{-9} per hour?

THE MEANINGS OF SIL

It has become so commonplace to equate SILs with specific failure probabilities that it is worth considering in some detail exactly what the various standards say with regard to the meaning of SIL.

IEC 61508 defines SIL as a discrete level (one out of a possible four) where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest, and it defines safety integrity as the probability of a safety-related system satisfactorily performing the required safety functions under all the stated conditions within a stated period of time.

The railway industry standards EN 50128 [Ref. 3] and EN 50129 are careful to avoid mentioning probability in the definition of SIL, which they define as a number which indicates the required degree of confidence that a system will meet its specified safety functions with respect to systematic failures. Confidence is used by these standards in its plain language sense and not with a mathematical meaning which can be evaluated or used in calculations, but it is true in practice that people are confident to use software which they are assured has achieved an appropriate SIL.

EN 50129 says “Because it is not possible to assess systematic failure integrity by quantitative methods, Safety Integrity Levels are used to group methods, tools and techniques which, when used effectively, are considered to provide an appropriate level of confidence in the realisation of a system to a stated integrity level”, while the table in EN 50128 which is the equivalent of Table 1 above uses descriptive terms ranging from “low” to “very high” in place of the probability values.

Despite the differences in their approaches to quantification, the IEC and EN standards both use SIL in two ways:

(a) As a measure of the desired probability or degree of confidence that software should achieve in satisfactorily performing the required safety functions (shown as SIL(R) above).

(b) As a prediction of the probability or degree of confidence that software will achieve in satisfactorily performing the required safety functions (shown as SIL(A) above)

A number of techniques, such as the use of risk graphs, are available for (a). They are all based on assessment of the risks of the application and, subject to all the uncertainties inherent in reliance on human judgement and fuzzy and incomplete knowledge of risk, are consistent with the probability calculus.

Prediction of the expected performance as in (b) is customarily based on showing that the software has been developed in conformity with one of the sets of techniques and measures recommended for the required SIL by the respective standard. This is summarised by Figure 2 above, where the achieved SIL is equal to the required SIL irrespective of the scale of the software.

SIL MISUSED TO PREDICT HAZARDOUS FAILURE RATE

In effect, the various SIL-based software standards all say that if any of the sets of techniques or measures which they recommend for a particular SIL are applied, software will achieve that SIL. Since the standards make no mention of the scale of the software, in terms of size, complexity or any other dimension, this is tantamount to saying that, regardless of scale, the same result will achieved whether expressed as a failure rate, probability or level of confidence. Although EN 50128 does not actually associate numerical values with SIL, and although EN 50129 clearly says that SILs are concerned with systematic failures that cannot be assessed by quantitative methods, the SIL which is claimed for a system is routinely taken as an assurance that the hazardous failure rate of the system will be that associated with the SIL as in Table 1 above.

Thus, a SIL 4 system is widely believed to have a probability of hazardous failure
in the range $10^{-9}$ to $10^{-8}$ regardless of its size, complexity and novelty.

Not only is this at variance with the entire science of software metrics when applied in the context of IEC 61508 or EN 50128 but it is also contrary to the engineering judgement and experience on which the technical content of the standards is based. In order to understand how unreasonable it is to believe in a unique value of probability of dangerous failure for each SIL it is necessary to consider the factors which give rise to defects and which determine whether defects will result in dangerous failures.

THE ORIGIN OF DEFECTS

Some of the principal causes of defects in software or other aspects of design are summarised in Figure 3 right. Most defects are the result of human error or misunderstanding in the various activities which transform the need into the product which is brought into use, although it is also possible for defects to be caused by the behaviour of software tools or by physical disturbance leading to corruption of the software.

It can be seen that software is likely to contain defects due to a number of causes: human error in performing software engineering activities, misunderstanding or ignorance of the application and its environment, and technical causes.

The number of defects due to human error in software engineering activities could be estimated as the product of the error rate per action and the number of actions to be performed. The error rate will depend on the competence of the people, the techniques used and the complexity of the software, while the number of actions will depend on both the size and the complexity of the software.

DEFECTS AND FAILURES

The various ways of defining SIL are concerned with the way in which software behaves in relation to safety functions rather than with the number of defects in the software. For the purposes of this paper a defect is taken to be any feature of software which will result in failure, while for failure the common sense definition used by the American Society of Civil Engineers, “failure is an unacceptable difference between expected and observed performance” is eminently suitable. Viewed in this way, “defect” includes not only lines of code which cause the software to behave in a way not intended by the designer, but also omissions and wrong intentions in the design or specification.

A defect will only result in a failure if conditions occur which cause the defective code to be executed (or in the case of omission require the presence of code which is not there). The distribution of failures which is exhibited by the software will thus depend on both the distribution of defects within the software and the distribution of demands made on the software. The distribution of demands is likely to be imperfectly understood, while the distribution of defects will almost certainly be unknown, so the prospects for accurately predicting the distribution of failures are likely to be slim.

For software to be acceptably safe it is the probability of unsafe failures rather than the number of defects which must be made acceptably low. The extent to which failures can be classified as safe or unsafe is very dependent on the application. For example in railway signalling systems, whose primary aim is to prevent collisions between trains, any failures which tend to stop or prevent train movements are regarded as safe; an unsafe failure is one which permits a train to move when it should not. In applications in other industries different aspects of software behaviour may be important and it may be less easy to designate any failures as safe.

Although in many cases not all failures will be unsafe, the software engineering measures and techniques recommended by the standards are almost universally concerned with reducing the number of defects, regardless of whether the failures which they cause are likely to have an adverse effect on safety. However, whilst the majority of generic software engineering techniques may not inherently differentiate between defects leading to safe or unsafe failures it may be possible to focus some techniques, especially those concerned with analysis or testing, on the avoidance or removal of defects which cause unsafe failures in a specific application.

The review above of the main factors which determine the probability that software will exhibit unsafe failures shows that they can be evaluated only to a very rough approximation, if at all, and that for some factors no relevant metrics exist.

If the relationship between the factors were well enough understood, and if suitable metrics existed for all the factors, and if sufficient data were available to
assign values to them, the unsafe failure rate of software could be estimated from the following formula.

\[ \lambda_{\text{usf}} = \chi S_c A F P_D \]  

(1)

Where:
- \( \lambda_{\text{usf}} \) = Rate of unsafe failures per hour;
- \( \chi \) = Number of defects per unit of software engineering effort;
- \( S_c \) = Effort in producing software as a function of size and complexity;
- \( A \) = Multiplier depending on size and complexity of application;
- \( F \) = Proportion of defects which result in unsafe failures;
- \( P_D \) = Probability per hour that a defect will be activated.

The term \( c \) can be regarded as representing the combined effect of the competences, methods and techniques applied to the engineering of the software. For software developed in accordance with IEC 61508 it would represent the effect of the combination of techniques that had been chosen:
- a set of techniques recommended for SIL 1 could be represented by \( c_1 \)
- a set of techniques recommended for SIL 2 could be represented by \( c_2 \)
- and so on.

It follows from equation (1) that the effectiveness of the SIL actually achieved may be greater or less than was actually required due to factors such as size, complexity, novelty, etc, as shown by Figure 4 where SIL(A) is not necessarily equal to SIL(R), unlike Figure 2 where they are equal by definition.

The non-software sources of systematic failure that are covered by the tables of techniques in EN 50129 are likely to be as susceptible to the effects of size and complexity as are software failures. The effectiveness of individual techniques such as design reviews or maintenance of a hazard log in preventing dangerous failures is perhaps even harder to quantify than the effectiveness of software engineering techniques.

**VISUALISING SIL**

Visual imagery can often be an aid to understanding abstract ideas, and so two approaches to visualising SIL are suggested here, in order to clarify the relation between SIL and probability of dangerous failure.

It is a principle widely applied in many industries that there should be multiple barriers or layers of protection between an initial hazardous event and a serious or catastrophic accident. One way of understanding the role of SIL in ensuring system safety is to consider how it fits into the “Swiss Cheese” model of accident causation introduced by James Reason [Ref. 6]. In this model a stack of slices of cheese represent successive layers of defences, barriers and safeguards, with the holes in the cheese representing errors or defects. The probability that a number of holes will align so that there is a path through the complete stack represents the probability that a combination of errors or defects will result in an accident.

In Figure 5 above the defences against collision between trains are shown rather simplistically as three slices of cheese representing the signalling system, the operating rules of the railway, and the vigilance of drivers and signallers. The effect of increasing the SIL of the signalling system would be represented by decreasing the size and number of holes in its slice.

If the values of Mean Time Between Dangerous Failures (MTBDF) of all systems developed according to the requirements of SIL 1 were plotted on a graph (supposing it was actually possible to know these values) then they would form a curve representing the distribution of the probability of failures.

If the values for all systems developed according to SIL 2 were then superimposed on the same graph they could be expected to form a second probability distribution curve to the right of but overlapping the SIL 1 curve.

If the values of MTBDF for all systems developed according to the requirements for each SIL were known and plotted on
such a graph then a picture similar to Figure 6 below would emerge, with four overlapping distributions. The curves in Figure 6 can be thought of as representing the values of SIL(A) in Figure 4.

MTBDF is taken to be the reciprocal of the probability of dangerous failure per hour in Table 1 above. MTBDF has been used rather than probability because the spread of MTBDF to the right with increasing SIL creates a more intuitively understandable image than a compression of probability towards zero.

In the light of the discussion earlier in this paper of the effects of factors such as size and complexity as represented by equation (1) it is quite credible that a small simple system developed according to SIL 1 might achieve a greater MTBDF than a large complex system developed according to a higher SIL.

**RANDOM AND SYSTEMATIC FAILURES**

In defence of those who accept a quantitative interpretation of SIL, it should be said that the differentiation between random and systematic failures is not so clear cut as the writers of the standards have tried to make it. In EN 50129, for example, safety integrity is described as comprising two parts, random failure integrity and systematic failure integrity, where systematic failure integrity is the non-quantifiable part of the safety integrity and relates to hazardous systematic faults (hardware or software). The standard goes on to say that systematic faults are caused by human errors in the various stages of the system/sub-system/equipment life-cycle (e.g. design errors) while random faults, in particular random hardware faults, are the result of the finite reliability of hardware components.

Although from the perspective of a design or maintenance engineer systematic faults may be non-random in the sense that, once they are known about, their effect on the behaviour of the system can be predicted, from the point of view of the operator who is not aware of them their presence is manifested as random failure of the system. The failure of hardware components is subject to the laws of physics: components fail because of combinations of electrical, thermal, mechanical and chemical effects whose results would be entirely predictable if the precise circumstances of the component were known. The apparent randomness of component failures results from lack of knowledge, analogous to the lack of knowledge of design faults before they have been discovered.

Thus all failures are deterministic from one point of view and random from another point of view. The difference lies in the extent to which the probability of their occurrence can be predicted.

**HAS SIL BECOME A MEME?**

The term meme was introduced by Richard Dawkins in his 1976 book "The Selfish Gene" as an example of a unit of cultural replication which could be thought of as an analogue of a gene. A more popular view of a meme is a contagious idea that replicates like a virus, passed on from mind to mind. The idea of SIL has certainly spread widely: the term is often used with confidence by people who are otherwise shy of the jargon used by specialists in safety related systems. Like a gene or virus it has started to mutate, and some of the more colourful misuses of SIL relate to its mutant forms.

The most common mutant form is the use of SIL as an alternative notation for probability: SIL 4 is much easier to say than "ten to the power of minus nine", especially for those not used to mathematical notations. In any case, as discussed at length above, this variant of SIL is not at all uncommon even in the minds of those who regularly consult and apply the relevant standards.

As the SIL meme has spread to minds more remote from the engineering of safety related systems its meaning has mutated to become a fuzzy notion of generalised safety or even simply high quality. This is evidenced by the instances that are sometimes encountered of claims of SIL 4 for track fixings or requests for the provision of SIL 4 electrification masts.

SIL may be on its way to becoming little more than a feel good factor in some quarters.

**SIL AND THE NARROWING OF CHOICE**

The insistence that safety related systems must demonstrate that they have achieved a SIL by compliance with the international standards can have the effect of unnecessarily restricting the technical solutions that can be adopted in order to meet a particular need.

Customers may be reluctant to agree to new applications of established products which were developed before the introduction of the standards because this means that they cannot claim a SIL by compliance with the standards. Such products are sometimes given grudging acceptance as "legacy systems" having "grandfather rights", but the implication remains that they are less safe because they do not have a SIL. There is a strong temptation to believe that the introduction of IEC 61508 and its railway cousins represented an advance in the technology of safety related systems, and that a SIL is a badge of progress.

In fact the standards have simply codified and ranked the techniques that were part of the development of the so-called legacy systems: they are a compilation of the state of the art at the time they were written, which was in fact several years before they were published, and a reflection of what was shown to be successful in the days when the grandfather rights were being established.

The absolute requirement to achieve a SIL also tends to inhibit the development of new techniques for safety related systems or software. Employing a new technique, no matter how effective, which is not among the techniques recommended by the standards will contribute nothing to the demonstration of any SIL, and so there is no incentive for innovation.
DOES SIL APPLY TO FUNCTIONS OR SYSTEMS?

It is very common to speak of the SIL of a system, although this is sometimes cited by those who are familiar with the standards as a misuse of the concept of SIL because the SIL should be associated with the safety function of the system rather than with the system itself. It this case it is actually not easy to see where the misuse lies. It is true that EN 50129 defines safety integrity as the ability of a safety-related system to achieve its required safety functions under all the stated conditions within a stated operational environment and within a stated period of time, and that IEC 61508, which insists on the probability aspect, defines safety integrity as the probability of a safety-related system satisfactorily performing the required specified safety functions under all the stated conditions within a stated period of time. However, in order to demonstrate that a required SIL has been achieved for a safety function it is necessary to produce evidence about the properties of the system that performs the function.

The correct way to describe the safety integrity level of a system would be to say that it is, say, a SIL 2 system with respect to its performance of a defined function or group of functions, and make no claim as to its performance of any other functions. However, since the standards, particularly EN 50128 and EN 50129, largely consist of recommendations which relate to the development of the whole system, or the whole of the software for the system, it is quite understandable that the designers should claim that the SIL has been achieved for the whole system and not just for specified functions.

It would help to avoid unnecessary costs in development and safety assurance if more attention could be directed to the possibility of implementing limited high-SIL functions in hardware and software which have been developed to low-SIL or even no-SIL standards. This may be achievable where dangerous failures of the function in question constitute only a very low and very unlikely fraction of all of the possible failures of the system. This is most readily understandable in the case of data transmission equipment, where the probability of a failure of a device such as a modem so that it generated data which was incorrect but continued to satisfy the system coding checks could be made vanishingly small by the use of suitable error-detecting codes. An analogous approach could be used with advantage in other fields, such as the design of systems with a human-machine interface where demands that the whole system must achieve a given SIL because this is required for just one or two out of many interface functions can either inflate costs or inhibit the provision of desirable functions.

ARE SIGNALLING RELAYS SIL 4?

Some of the common misunderstandings and misuses of SIL can be found in the following dialogue.

— “What is the SIL of a signalling relay?”
— “They don’t have a SIL.”
— “So they’re not safe then.”
— “They are very safe. The probability of wrong side failure is less than 10\(^{-10}\) per hour.”
— “But that’s lower than SIL 4! You can’t claim that.”
— “They were designed before SIL was even thought of,”
— “Now you’re just claiming grandfather rights.”
— “Anyway, EN 50129 only applies to electronic systems: relays are electromechanical components.”
— “Trust you to split hairs over definitions. All of those things about hazard identification, safety requirements, system architecture and so on are really independent of technology. If the records of those things can’t be traced for signalling relays they can’t even be SIL 1, never mind better than SIL 4.”
— “But we have empirical data. Millions of relays have been in service for decades.”
— “Well, all I can say is that you have been very lucky so far.”

CONCLUSION

The association of a fixed unique probability value with each SIL can give a misleading impression of the actual safety performance which a system is likely to achieve. It may have a serious adverse effect in focusing attention on a checklist approach to compliance while distracting attention from potential problems resulting from size, complexity or novelty.

The wider linguistic confusion over SIL could be hard to control but may be harmless in itself, so long as there are people capable of laughing at some of the more outrageous statements. It is more serious that the culture of SIL conformity may inhibit both innovation and the continuing use of established systems.

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Implementing the Victoria Line Overlay Signalling System

by Peter Clifford 1, Thomas Godfrey 2, Andy Heath 3, Richard Roberts 4

Paper to be read in London on 11 February 2009

Background

The legacy Victoria Line Signalling

The existing Victoria Line was opened in four sections between 1968 and 1972, the official line opening ceremony being conducted on 7 March 1969 by Her Majesty the Queen. The line is just over 13 miles (21 km) long and is formed of deep-level tube tunnel except for the train depot at Northumberland Park which is in the open. It serves 16 stations with a fleet of 43 trains, 37 of which are in service at peak hours. It operates a peak service of 28 trains an hour between Seven Sisters and Brixton. About one train in three reverses at Seven Sisters. The line is controlled from a central control room near Euston main line station.

The automated signalling system is based on a.c. coded track circuits which not only provide train detection but also carry the Automatic Train Protection (ATP) codes from the trackside equipment to the trainborne systems. In areas where there is point work, ‘V’ style mechanical interlockings are used, the ‘V’ indicating a vertical frame in which lever contacts, the levers themselves and the locking till are aligned. The levers in the interlocking machine are driven from normal to reverse or vice versa by electro-pneumatic cylinders.

Colour-light lineside signals are provided with two or three aspects, red / green or red / green / lunar white. Three-aspect signals are provided on sections where intermediate lineside markers referred to as ‘headway posts’ are provided. These headway posts mark locations where automatically driven trains can legitimately come to rest if trains are blocking back. The aspects indicate the following. A red light is a Stop; a green light is a Proceed for a manually driven train; and a lunar white is a Proceed for an automatically-driven train only, being regarded as a Stop in manual operation.

The signalling circuits are arranged such that a green aspect will only be shown when authority can be given to approach the next colour light. With this arrangement a manually driven train is never required to stop at any headway posts. Signals are provided at all platform locations, at divergences and convergences, and at entry to and exit from sidings. Electro-pneumatic shunt signals are provided for moves to sidings and the entrance to the depot.

Track circuits of double block joint arrangement feed code to the trainborne Automatic Train Control (ATC) systems. The signalling system supplies the track circuits with a continuous 125 kHz supply interrupted by one of four codes (120, 180, 270 or 420 pulses per minute), so that a pulsed output is fed to the track circuit depending upon track circuit occupancy and routes being correctly set. There are code pick up coils on the front of the train that detect these codes. The 120 code is not recognised by the trainborne systems. If the train receives no code or the 120 code it will apply its emergency brakes and come to rest. Also fed into the rails and picked up by the train are automatic driving command spots in the range of 1 to 20 kHz.

Figure 1. The Supply Chain

Transport for London (TfL)

London Underground (LU)

Metronet (MR)

Bombardier Transportation (BT)

Westinghouse Rail Systems Limited (WRSL)
Through the combination of the pulsed track codes and the automatic driving commands, the automated system determines how to control the train. In this way an automatic train is driven at full speed along the railway when a 420 code is present, a 270 code indicates that it can motor and brake at around 22 to 25 mph (36 to 41 km/h), and a 180 code indicates it can proceed at up to 25 mph (41 km/h) but not motor. An automatic driving command referred to as a brake spot is turned on or off depending on whether a train is required to stop at a signal or headway post. Other automatic commands are located on the approach to and in platforms to ensure accurate stopping at stations.

**The Migration Strategy**

The VLU represents a first for LU in that it requires migration from one automatic train operation system to another. Moreover the journey-time capability system of payments to its infrastructure companies under the PPP contract means that any worsening of run times or headways would result in a loss of income for MR, so introduction of the new rolling stock in any manually-driven mode during migration would not be acceptable.

Fitment of the 1960s ATC system to the new trains was considered but ruled out due to the problems anticipated with the new trains was considered but ruled out due to the problems anticipated with the new trains being withdrawn, the full Asset Replacement phase will be implemented, during which the last of the legacy signalling equipment will be removed. New track circuits will be installed and the WESTRACE interlockings (acting as simple interfaces for DTG-R up to now) will take over full control of the sites, and point machines will be replaced (see Figure 2).

The complex interaction between the VLU programme’s various work streams led to the need for a graphical representation of the various configuration stages the railway would go through, to assist with planning and providing guidance to outside parties. Systems engineers in the project team devised the concept of a tube line diagram with milestones represented as stations along the line. This became known as the “Tube Map to Success” and also features reminders of target dates, key deliverables and assurance approvals. It is shown in Figure 3, where the arrow indicates current progress.

**The Overlay System**

This section addresses the Signalling Overlay, or Trains-Only Overlay, architecture and migration stage. As the name suggests this architecture focuses on enabling operation of the 2009 stock in mixed running with 1967 stock. All other aspects of the operation of the railway remain within the existing Victoria Line systems.

Before describing the Trains-Only Overlay architecture it is essential to state the guiding principles for this phase of the upgrade, as follows:

- The 2009 stock shall remain within the limits of movement authority defined by the existing signalling;
- Operation of the 2009 stock shall mimic that of the 1967 stock;
- The overlay signalling shall have a read-only interface with the existing signalling.
products (see Figure 4). DTG-R builds on well-established fixed-block signalling principles.

The concept of operation is that the railway is described by a number of blocks, each of which has Block Proceed (BP) and Block Not Occupied (BNO) and may have one or more vital Overlap Clear (OLC) functions. The BP, BNO and OLC functions are derived within the WESTRACE logic based on the vital functions (i.e. Interlocking Machine lever position, track circuit occupancy, point detection, emergency stop plunger status, key switch operation, etc.) read from the existing signalling. WESTRACE then passes BP, BNO and OLC to the Fixed Block Processor (FBP).

The purpose of the FBP is to package this information and operate protection features to make it suitable for transmission over radio. The Radio Transmission System comprises Fixed Communications Units, Trackside Antenna Subsystem, Mobile Antenna Subsystem and Mobile Communications Units. In the main, the Trackside Antenna Subsystem uses radiating cable along each tunnel bore. However at the depot entrance a free space antenna is used to cover the slightly more complex layout efficiently.

The ATP receives BP, BNO and OLC from the Mobile Communications Units and combines them with its knowledge of location within the geographic data to determine the Limit of Movement Authority (LMA) in terms of both the safety limit and driving limit. The ATP then uses diverse safety limit enforcement and driving limit enforcement algorithms to evaluate continually whether the train is at risk of exceeding either the safety or driving limit, and to apply the emergency brakes to prevent this (see Figure 5). The ATP determines absolute train location from Absolute Position Reference (APR) transponders. These provide unique identifier codes, read by APR readers as the train passes over the transponder. Between APR transponders, speed and distance travelled are determined diversely, from speed probes and Doppler radar units.

The LMA is passed to the ATO which mimics the safety limit enforcement function conducted by the ATP, but predicting a control margin into the future to enable braking profiles to be calculated that ensure that it is able to drive the train close to the ATP limit without provoking ATP intervention (see Figures 6 and 7).

To provide high levels of service availability redundant product solutions
Operation of the 2009 stock shall mimic that of the 1967 stock.
The existing signalling uses a number of three-aspect signals, the third aspect being a “White”. The 1967 stock is only permitted to pass a white signal in automatic mode. To mimic this restriction and enforce it the application data for the DTG-R system configures different driving limits between automatic and protected manual operation. Thus in protected manual the driving limit is held at a signal until the LMA extends to the first overlap from the next signal. In addition, as part of the driver interface and train functionality, a 2009 stock train running in protected manual mode will generate an alarm if it is operated above 22mph in just the same fashion as the 1967 stock as this is the speed at which signal sighting has been designed for the existing signals.

The overlay signalling shall have a read-only interface with the existing signalling.
As we hope is clear from the foregoing description, no part of the operation of the DTG-R overlay requires vital functions to be fed from the overlay signalling into the existing signalling.

Challenges
Introduction of new signalling systems presents many challenges, both technical and operational. In this paper the authors have tried to convey both the depth and breadth of the project by picking out real examples that have occurred at all levels of the supply chain.

Introducing a new signalling system
Throughout the project the Victoria Line has remained operational during the day, and access has generally been limited to three extended nights per week plus a number of weekend shutdowns. Keeping the railway running while the signalling system is being replaced needs a realisable migration plan, but also needs to recognise the constraints on access to the railway.

An area that can consume large amounts of access is testing. To reduce the reliance on testing on the line itself, a range of approaches have been developed by the Supply Chain and used to great effect.

Factory test rigs
A number of different test environments have been used to enable testing of individual products and the generic system. Different test environments make it possible to focus on specific aspects of the overall system. The factory test rigs have also been used as part of an incremental development. Perhaps the best way to illustrate this is to focus on just one test environment, referred to as the System Test Equipment (STE). This was first used as a prototype of a Signalling Equipment Room (SER), or rather of all of the Westinghouse equipment within an SER. That is, an application design was created for a fictional location, based around Victoria, and issued first to the site installation team and then to the site test
This enabled any issues with the build to be identified away from the railway, and before on-site installation commenced, thus reducing rework and access requirements.

Early prototype build of the SER products also enabled flexibility to be built into the layout and cubic designs. This was of great assistance in addressing the challenge posed by space—or rather lack of space—to install the new signalling. Whilst the Victoria Line was originally designed with additional equipment rooms for future upgrade, over time these have been used for other systems such as more advanced and sophisticated communications infrastructure. Therefore space was at a premium and maximising the flexibility of the new signalling to fit into a wide variety of differently shaped and sized rooms has proved important (see Figure 8).

This prototype SER then became the core of the STE, with the addition of partial adjacent sites, the trainborne equipment and simulated external interfaces for the train. Within the factory the STE provides as much of the real system as possible, so simulation is limited to speed sensors and APR readers alone. The STE has been extended to include the communications interfaces from the train, and thus supports train integration work. The first use of the STE and other test environments was to demonstrate the connectivity, i.e. the backbone of the system concept, very early in the project. Whilst this may now seem a small step, particularly to those at the heart of the project engineering work, it provided the wider project team up through the supply chain with something tangible to focus on. In large and complex projects spread over long periods, managing the people and their expectations and giving morale or confidence boosts such as this is as important as the ‘real’ engineering. The confidence boosts such as this is proving important and thus vital for train teams up through the supply chain.

DTG-R data correspondence testing has been achieved using a development of a sophisticated track surveying tool termed KRAIB. This provides very accurate measurement of distances along both running rails together with stepping through the compiled DTG-R data, to enable testers to confirm on site at the time of measurement that the data items and the railway align correctly.

**Off-site test track**

Bombardier have a test track at Derby on which the integrated rolling stock and signalling system has been extensively tested. It enables each new train to be dynamically tested under ATO and ATP operation prior to delivery to the Victoria Line. Access is close to 24 hours a day, seven days a week, which dramatically reduces elapsed time by extensive shift working for testing.

The first use of the Bombardier Derby test track was with the “Configuration B Test Train,” a train of 1967 stock fitted with the new signalling system in passive mode that enables demonstration of the integrated train and trackside functionality prior to completion of Train 1, the first pre-series train of the 2009 stock. As with the early integration on the STE, the Configuration B Test Train was part of a theme of early integration and test work, the aim of which was to “validate” the overall system before the detailed and very formal verification and validation of the products and system. This proved invaluable in identifying minor design flaws early in the development cycle and thus enabled faster resolution at lower cost.

**Application data test tools**

A range of different tools have been developed to enable application data to be tested without disruptive access to the railway. In common with a number of electronic interlockings, WESTRACE has a Graphical Simulator (GSIM) that is validated to support control table and principles testing in the office environment.

Correspondence and interface testing for the installed system is then carried out at each site. An analogous approach has been adopted for the DTG-R components. As with GSIM, the technology strategy is to implement the key product functionality on an office computer and then verify and validate this. For DTG-R this tool is termed Geographic Data Simulator (GDSIM). It enables functional testing of the key safety functions, e.g. authority generation against the relevant control tables and principles. This leaves the need to conduct correspondence tests between the DTG-R data and the railway.

**Developing the train / signalling interface**

The introduction of the new 2009 stock generated a number of electromagnetic compatibility (EMC) challenges, particularly with respect to the legacy signalling equipment.

**The threat**

The 1967 stock uses conventional d.c. motors controlled via a network of resistors that are progressively cut out and reconfigured from series to parallel using camshafts to open and close contacts within the circuit. The main sources of interference are transients generated from switching operations and substation harmonic currents arising from unbalanced harmonic voltages on the traction system, causing currents to flow through the train impedance.

The 2009 stock is significantly different from the legacy 1967 stock. It uses a.c. traction motors supplied with a pseudo-a.c. waveform derived from switching the d.c. traction supply using insulated-gate bipolar transistors (IGBTs) as shown in Figure 9.

IGBT technology is well-established in the rail industry. However the switching action of the IGBTs generates unwanted noise on the d.c. input to the Motor Converter Module (MCM) mainly at harmonics of the IGBT switching frequencies. The level of train-generated switching harmonics leaving the train is controlled by a single-pole filter on the d.c. input of each MCM. The performance of the filter is dominated by the size of the filter inductor, which also sets the values of the train impedance. This in turn controls the levels of substation harmonic currents flowing back into the traction supply due to unbalanced harmonic voltages on the traction system. For the 2009 stock the final choice resulted in the smallest and lightest inductor (due to size and weight restrictions) that provided train impedance similar to the 1967 stock.
In the 2009 stock, train-generated switching harmonics also enter the running rails via capacitance in the windings of the a.c. motors. While this is minimized by the train design it is a significant contributor to signalling equipment interference.

Table 1 (right) indicates the major differences between the interference generated by the two generations of trains.

**The potential victims**
From a signalling perspective the introduction of the 2009 stock posed a potential threat to many legacy systems, but to the following vital equipment in particular.

Equipment unique to the Victoria Line and designed to work only with 1967 stock and not covered by any LU signalling compatibility standards:

- The Code Acceptance Unit, used to energise the track relay in the presence of correctly pulsed 125 Hz, is susceptible to broadband interference which can cause the unit to fail right side
- The 67TS Train Safety Unit, used to energise the Code Trip Valve in the presence of correctly pulsed 125 Hz and to energise the correct speed code output to the Automatic Driving Box, is potentially susceptible to single tones around 125 Hz which can cause the unit to fail right side, and could potentially cause wrong-side failures under degraded infrastructure conditions.

**Traction earth faults**
Traction earth faults can be train generated (i.e. a short on a train motor) or track generated (i.e. a short between a traction rail and a running rail). The LU traction supply system is designed to be resilient to earth faults, and so the new train must be able to operate in the presence of earth faults. On the 2009 stock trainborne earth faults are detected and the offending train unit is disconnected from the traction supply. However the train’s noise reduction scheme for common mode noise provides a path through the train in the presence of infrastructure earth faults which results in both trainborne and substation generated noise flowing in the running rail where it has a greater propensity to couple into the victim systems.

By way of illustration Figures 10 and 11 show how the presence of an earth fault causes both common mode and differential mode interference to pass through the Code Acceptance Unit of an adjacent track circuit.

**EMC work conducted**
LU has developed specific EMC standards based on ENS0121 and signalling compatibility standards for equipment used more generally on the LU network. While these standards covered the Delta they did not address the compatibility of the Code Acceptance Unit or Train Safety Unit.

Due to the age of the equipment very little was known about the EMC performance of the Code Acceptance Unit or Train Safety Unit, and extensive work was carried out to characterise the performance in the presence of broadband interference at the equipment terminals. At the same time extensive modelling and testing of the infrastructure was carried out to clarify the expected coupling between the 2009 stock and the signalling equipment under different infrastructure conditions. The results of these studies fed directly into the EMC safety case.
For the Delta, the noise generated by the 2009 stock in the presence of traction earth faults exceeded the susceptibility limits defined in these standards. The age and consequent lack of provenance of the susceptibility limits for the Delta in the standard resulted in a requirement to re-evaluate the performance of the B and C type Delta when fitted on the Victoria Line. This study showed that the susceptibility of the Delta to interference could be improved significantly by resetting. As a result concessions have been developed for setting up the Deltas and showing that the 2009 stock can operate against the reset Delta.

**Summary**

The result of the EMC work was that no changes were needed to the train and minimal work on the infrastructure. Clearly this is a good return on the work invested, as minimal change means no major cost and time impact to the project.

**Interfacing with the legacy infrastructure**

Interfacing with the legacy infrastructure has presented a number of technical and operational challenges. Finding the “right people”—engineers and operators with depth of knowledge of the legacy systems as well as a great understanding of the new requirements—has been a common theme in this work, and one which the supply chain has managed relatively well. This section provides a brief overview on just two aspects.

**Connecting new to old**

For the DTG-R system to act as an overlay system it needed inputs from the legacy signalling system comprising route status and track occupancy. This presented two major problems.

Interconnection of the legacy signalling system which utilises a ‘fault screen’ power supply and the new signalling system which uses an earth free power supply.

The use of type QNHX1 relays to provide the repeat of safety critical interface functions from the legacy Interlocking Machine Room/Relay Room (IMR/RR) to the new SER where there are insufficient spare contacts on the existing type QN6 relay pairs. (The QNHX1 is a BR930 series relay operating from a nominal 100 V a.c. supply and having an integral full wave rectifier. The QN6 is a special 100 V a.c. relay developed by LU for the legacy Victoria Line, incorporating a full-wave rectifier mounted on the relay base. Its key feature is a high drop-away voltage, of 60 V).

Several solutions were considered, such as isolating transformers or kiosks external to both IMR/RRs and SERs to provide a physical and electrical boundary. Although feasible, these solutions would have required significant work and equipment. Therefore a cross-Company review was carried out which resulted in a proposal whereby a d.c. feed from the SER to the IMR/RR is taken over spare contacts (or contacts of QNHX1 repeater relays) in the IMR/RR and then back to the SER via two multicore cables.

In the SER two relays are energised for each function. A contact of each relay is fed in series to the WESTRACE to provide diversity of the safety critical functions. As an added protection, the inputs to the WESTRACE are checked against diverse inputs to a Diverse Monitor Controller, to monitor for relays acting out of sequence (see Figure 12).

Through close Company working, and following a rigorous safety assessment of the arrangement described above, the Project was able to demonstrate that there was no safety benefit in isolation transformers or kiosks and that the two systems could be interconnected safely.

**Installation of APR transponders**

In order to align with the APR interrogators underneath the trains, APR transponders have to be fitted in the four-foot (that is, between the running rails), on the West side of the centre (negative) power rail on each road. Whilst this might appear straightforward, several features of the Victoria Line presented problems.

As the line is a deep-level tube tunnel, the four-foot is used in different ways at different times. For example it must be kept clear to permit passengers to walk from a train stranded in a tunnel to the safety of a station platform. Now due to the shape of the tunnel it is only possible to store rails associated with track renewal work in the four-foot. A complicating factor is that lighting is normally installed on one side of the tunnel only. This is referred to as the “light side,” the opposite side being referred to as the “dark side.” It is only permitted for rails to be stored in the dark side of the four-foot, so that passengers have the maximum light available should they have to walk along the track.

After much consultation with maintainers and operators the Supply Chain converged on a solution that involves mounting the transponders flush with the tops of sleepers. In the case of access pits in platforms they are mounted on hinged brackets that can be moved aside to permit track maintenance work. Moreover procedures have been developed to ensure that track and signalling disciplines coordinate closely when carrying out any work associated with dropping rails or replacing sleepers, as this can lead to transponders not being read by the trains.

**Safety assurance and operational readiness**

Right from the outset the twin challenges of safety assurance and operational readiness have received significant attention. Now, as the first major milestone approaches, the true merit of this attention is being tested as LU and MR prepare to accept the Safety Case and the Operator (LU) prepares to commence traffic hours operation with the new trains. This section touches on how these two challenges have been met.

**Operational readiness**

The new system impacts both on the train operators and the service control staff. From a train operator’s point of view it was decided to use specially trained drivers for the testing phase. However it would soon become impractical to use a dedicated pool of train operators familiar with the 2009 stock once fleet migration was under way. The challenge was to ensure that all train operators were trained on the new stock and its DTG-R ATC equipment at an early stage.

As a result Bombardier developed cab-simulators (a second one was ordered when the required workload was determined), which feature extremely accurate representation of the signalling equipment behaviour as well as of the train itself.

The need for train operators to be able to swap readily between the two types of train led to the need to mitigate the possibility of confusion over applicable rules and procedures. The Operations representatives on the project team therefore sought successfully to retain the legacy rules as far as possible during the fleet migration.

Whilst the legacy Victoria Line control room retains control during the Signalling Overlay phase, consideration was given to what changes if any were required to it. The most significant concern was lack of visibility of the DTG-R trackside equipment, which has been addressed by the provision of a Signalling Alarms Monitor (SAM) visual display unit giving information on the
health of all new DTG-R SER assets to the signalling technician’s desk in the control room.

Analysis of expected inter-station run times with the new, faster, 2009 stock trains has given rise to concern that a bunching effect will be seen when several run one after another, leading to undesirable gaps in the train service behind them. Hence the performance of the new trains will need to be adjusted temporarily to match the run times of the legacy trains. This measure will be revoked once the last legacy trains are withdrawn.

Assurance
Much attention has been paid to the issue of assurance on the VLU project, mainly due to factors such as the novelty of the DTG-R system and the relatively long supply chain. The challenge was to rationalise and speed up approvals without compromising on quality.

In the early stages the need to allow installation of new and novel products on the railway prior to any formal assurance submissions was a significant concern. MR established a ‘Consent to Install’ process, under which their suppliers submitted product technical files for sign-off at a design review meeting attended by the relevant specialists (predominantly in fire performance at this stage).

When the time came to power up equipment for initial testing the relevant technical file was updated and submitted for a similar ‘Consent to Energise’ design review. Electromagnetic compatibility was the primary focus for that approval.

Traditional Works, Plant & Equipment Regulations submissions have been made as the project has progressed. Face-to-face dialogue has been used to avoid misunderstanding and unnecessary rejection of submissions.

The “SORT(ED)” process (Sign-Off Review Team - Engineering Directorate) has allowed providers of assurance to make “context presentations” at fortnightly meetings. Two weeks later the LU Asset Engineers receiving the assurance evidence are required to explain and justify their comments. Where a problem worthy of rejection such as a lack of evidence emerges, the submission is held over until the problem can be resolved. In this way, the project has achieved a 100% first time success rate with submissions, albeit with some brief delays for resolution of problems.

To avoid any unnecessary delay, safety case evidence for the new DTG-R system is now being issued simultaneously to all parties reviewing it, directly from the engineers producing it. Parallel reviews then take place in the project team and the Asset Engineers and Independent Safety Assessors, to minimise the overall process time.

Project delivery
In late 2005 the four organisations involved tackled the long supply chain issue further by co-locating their respective teams in a single office building in London. Clearly many Westinghouse and Bombardier staff needed to remain with their specialist facilities, in Chippenham and Derby respectively, but nevertheless the move allowed much-improved dialogue between all parties. The building concerned is Euston House, a former railway head office located conveniently for the Victoria Line.

Also in 2005, the project managers in all four companies fostered a culture of joint working in order to encourage all involved to set aside contractual divisions and work together towards common objectives. This is referred to as the One-Team initiative and has been reinforced by various cross-supply-chain team events.

Most recently, in 2008 the re-integration of MR with LU offered the possibility of pooling scarce specialist resources between the two organisations. Amongst other changes, LU project managers have now taken over responsibility for delivery of the project, and a combined MR-LU independent review team has been established.

Closing Remarks
At the time of writing, formal validation testing of the DTG-R system is under way on the Victoria Line, and the first new train is expected to begin operation in traffic hours in mid-2009.

Good co-operation and strong engineering across all layers of the supply chain have been vital to understanding and resolving the challenges faced by the project. Whilst we may all say “that’s just common sense,” the authors acknowledge just how difficult it can be, especially when working in any novel contractual framework. In this respect all those working on the VLU would accept that the Project has learned some important lessons and is now more streamlined and better equipped to tackle the future Control System Overlay and Asset Replacement migration stages. We hope that some of these lessons can be transferred to other re-signalling projects.

The authors would like to acknowledge the help in preparing this paper of, amongst others, John Whaley, Eric Wright, Andy Gordon, Peter Neal, Chris White, Mark Glover and Ken Davies.

Figure 12. Schematic showing repeater circuits to connect old to new.
On the afternoon of Friday 28 November 2008, following a pleasant lunch, members were treated to a series of talks about railway activities in Poland and around Poznań in particular, while guests went off to see what the shops had to offer. Bogdan Godziejewski from Movares introduced the session with some background information about the railway network. The Polish rail network consists of around 19,000 km of standard gauge railway, with 11,000 km being classed as main line. The majority of the network is in the western part of the country, built when the area was part of Germany from 1871. The eastern part of Poland, formally Russian territory, has less of a network. The number of assets the railway owns is staggering; 14,600 level crossings (3,000 manned) and 47,211 sets of points (700 in Poznań alone). Interlockings are split between relay type (42.8%), electro-mechanical (53.5%), electronic (2%) and hybrid PC and relay mix (1.7%). The 2% of electronic interlockings are split between Siemens SIMIS W, Thales L90 PL and Bombardier Ebilock 950 or earlier. Virtually all trains hauled by electric traction, powered from an overhead 3 kV catenary.

Following a presentation by Thales and Bombardier on the re-signalling taking place at Poznań Główny station, the group were taken to see the new system at first hand. The turnkey contract is to replace the previous ageing signalling, telecoms network, power supply and operational buildings. The heart of the new signalling system is provided by a Thales L90-5 interlocking, controlled by a VDU based system.

Some alterations have been made to the track layout but it has mostly been replaced on a like for like basis. Signals and point machines have all been replaced and Alcatel axle counter systems provided throughout.

Saturday morning saw the group meeting back at the main railway station of Poznań in time to board the 09:28 steam operated train service to Wolsztyn, some 60 km (37 miles) away towards the south west and towards Dresden. The weather had changed from the previous day, the sun had gone in and it had started to rain, the temperature remaining much the same. The scene at the station was extremely evocative, with steam leaking from the connections at the ends of the coaches creating localised clouds, interspersed with clouds of sulphurous yellow smoke from the firebox of our charge, 2-6-2 locomotive number 01-49-59. The service is operated on a daily basis by Polskie Koleje Państwowe SA (PKP), the main Polish train operating company, with the help and support of the Wolsztyn Mutual Trust Society and is the last mainline regular steam operation in Europe. Along the route of gently rolling farmland and wooded copses, there were around 15 stops, a number of local people alighting and joining at many of them. The stops also served as points for members of the IRSE party to join the train crew on the footplate two at a time, enjoying a rare opportunity to travel at line speed on a scheduled passenger service.

After arriving at Wolsztyn and taking the opportunity to photograph our charge, the group were shown around one of the two signal boxes that control the large station, the museum and the roundhouse steam shed. The signal box with its mechanical locking frame was very much like a museum in its own right.
having been built in 1905, and remaining largely unchanged since, except for installing double glazed windows.

The roundhouse is a quarter of a circle with facilities to house eight steam locomotives and radiates an atmosphere that can only be created by more than a hundred years of coal dust, oil grime and sulphurous smoke. A lunch break was undertaken in a hostelry adjacent to the station, where members and guests were plied with traditional Polish fare, before returning to Poznań on a modern two coach diesel multiple unit in the late afternoon.

Sincere thanks go to the PKP and the Wolsztyn Mutual Trust Society for their hospitality during the visit to Wolsztyn, along with the sponsors, Atkins & Thales.
Statue of Adam Mickiewicz, Poland’s greatest romantic poet

Batteries and Standby Generator in Poznan Control Centre

Local train at Poznan

Shunting Signal

New signalling equipment at Poznan

photos: Ian Allison

More photographers

Wolsztyn
IRSE visit to Poland

Poznan tram

Members observe the simulator at Poznan Control Centre

Poznan Control Centre

Evening meal in Poznan

A short introduction to Polish Signalling

Bogdan Godziejewski of Movares presents an introduction to Polish signalling on Friday afternoon in Poznan

Members spotting trains and point machines outside Poznan Control Centre
IRSE visit to Poland: the heritage angle

Signals at Wolsztyn
Telecoms Relics in Wolsztyn Museum
IRSE Members’ train from Poznan to Wolsztyn
Wolsztyn Roundhouse

Wolsztyn signalbox and interlocking

photos: Ian Allison
The Ongoing Modernisation of the Polish Rail Network

On 9 January 2009, it was announced that Bombardier Transportation (ZWUS) Polska Sp. z o.o. is to deliver a further signalling and control system to the Polish rail network company PKP Polskie Linie Kolejowe (PKP PLK). They will deliver a state-of-the-art INTERFLO 200 signalling solution on the Tczew section as part of the modernisation of the E65 Main Line from Warsaw to Gdynia. The full modernisation contract has been awarded to a consortium led by PKP Energetyka Sp. z o.o. The Bombardier share has a value of approximately 20 million euros ($28 million US) and is scheduled for completion by June 2010.

They will design, manufacture, deliver, install and put into operation its INTERFLO 200 solution which consists of an EBI Screen control room, EBI Lock computer-based interlocking systems, and an EBI Track train detection system.

The INTERFLO 200 solution is already in operation in Poland and is currently being delivered for PKP PLK on the E 65 line - Nasielsk LOT A section. They have also installed control rooms on the E-20 line (Berlin-Warsaw-Moscow) and the E-30 Line (western State border – Wegliniec - Legnica-Wrocław-Opole).

Anders Lindberg, President of Bombardier Transportation’s Rail Control Solutions Division, said: “This contract is testament to our expertise in the Polish market and the success of our technology already in operation. We look forward to working closely with the customer on this new project.”

Sławomir Nalewajka, Managing Director of Bombardier Transportation (ZWUS) Polska Sp.zo.o., commented: “We are very proud to have won this new order, which reflects the confidence our customer places in our solutions. Through our production site in Katowice and engineering office in Warsaw, we look forward to continuing to be a leading contributor to the modernisation of the Polish rail network.”

Westinghouse Trainees Scoop National Awards

Four trainees from Westinghouse Rail Systems received industry recognition at the 2008 GoSkills Passenger Transport Awards, held in London on Thursday 13 November.

Now in its third year, the GoSkills Awards have quickly become established as a major industry event – recognising and celebrating the achievements of learners and employers in the UK Passenger Transport Sector. The successful Westinghouse trainees were:

Michelle Coombs – Winner, Rail Apprentice of the Year;
Helen Eatock  - Winner, Management and Leadership Achiever of the Year;
Alan Cox – Finalist, Rail Apprentice of the Year;
Darren Wiltshire - Finalist, Management and Leadership Achiever of the Year

Speaking after the awards, Anne-Marie Thorpe, Graduate and Training Programme Manager at Westinghouse said: “We are absolutely delighted with the success that our trainees had at these awards and our congratulations go to Michelle, Helen, Alan and Darren for their outstanding achievement.

“Our continued success at the GoSkills Awards is also a great reflection of the hard work of our Learning and Development Team, putting Westinghouse firmly on the map when it comes to training standards in this particular industry sector.”

High Speed Signalling success in Spain

Dimetronic Signals, part of Invensys Rail Group (IRG), announced on Monday 5 January 2009 that the company has been awarded, in joint venture with Thales, the contract to provide the signalling and train control for the 150 km Barcelona Figueras High Speed Line (HSL) which is currently under construction by ADIF, the Spanish Rail Infrastructure organisation.

The contract is worth £43.6m to Dimetronic reflecting 39% of the total contract value. This important order represents the seventh consecutive win for Dimetronic which is now rapidly building a reputation for expertise in the management and delivery of High Speed/ERTMS rail signalling contracts worldwide.

“This really does reflect the good job done delivering HSL contracts which has enabled IRG to win customer confidence. I am particularly pleased that we have been awarded this contract as I believe it endorses not only IRG’s proven technology but our ability to manage large contracts of this nature on time and within budget,” said Jesús Guzman, General Manager of Dimetronic.

Barcelona Figueras project, which follows the recently commissioned Madrid to Barcelona section, is particularly important as it represents the last section of the new High Speed Line (HSL). When the project is completed the new line will join the Figueras - Perpignan section and will allow passengers to travel effortlessly between Madrid and the French border in a little over three hours.

Dimetronic will be responsible for providing the interlockings, LED signals, CTC control system, ASFA train protection system, power supply system and auxiliary civil works. The contract also includes maintenance for three years following commissioning.
MODURBAN project successfully concludes with Madrid real-time demonstrations

After four years of work, MODURBAN, the €20 million research project is now reaching its final conclusions. On 18 December 2008 in Madrid, those responsible for the project presented and showcased some of the key MODURBAN results on the Metro de Madrid network.

MODURBAN stands for Modular Urban Guided Rail System and is a joint Research & Development (R&D) project funded to 50% by the urban rail market stakeholders and 50% by the European Commission under the EU’s Sixth Framework Programme for Research and Development. The project was launched in January 2005 and is due to finish officially in March 2009. The aim of MODURBAN is twofold: to provide common functional specifications for urban rail operators (called Functional Requirement Specifications (FRS)), and to provide a common technical architecture for urban rail manufacturers. Project management has been handled by UNIFE – the Association of the European Rail Industry.

Speaking in Madrid on 18 December 2008, UNIFE’s Head of Railway Systems and MODURBAN Project Manager, Bernard von Wullerstorff stated, “MODURBAN was the first of its kind Europe-wide concerning a joint pre-competitive R&D project. It brings together all the major rail industry suppliers such as integrators and system suppliers and all the big European rail operators and universities.”

“Overall, the ambition of those involved in the project was to achieve cost reductions for buying and running urban rail transport systems, and this through the development of the Functional Requirement Specifications - FRS,” he said. The MODURBAN FRS has been fully endorsed by all the operators and the entire project consortium. “The cornerstone of the project and indeed major result after almost four years is undoubtedly the FRS. It is a complete set of ‘ready-to-use’ requirements, suitable for all urban rail operators, covering systems ranging from manually driven trains to fully driverless operations. The benefits therefore are crystal clear: the assurance of a comprehensive set of requirements and a real performance specification,” said Carlos Rodríguez Sanchez of Metro de Madrid.

Bernard von Wullerstorff adds, “all in all, these agreed requirements clarify the roles and responsibilities between the operators and the suppliers – and that today is REAL progress.”

Among the developments during the MODURBAN project have been the success in defining a commonly agreed Fault tolerant Data Communications System where one network supports all applications (train control, video, passenger information, etc), and where this Data Communications System is interoperable/interchangeable between the different suppliers.

On the Metro de Madrid network today, MODURBAN demonstrated a selection of results, namely:

- The Intelligent Driving concept;
- Interchangeable Data Communication System operation;
- Passenger Information System and Video onboard and wayside operation;
- Light Weight Materials (prototype development of light weight grab rail).

All publicly available results, promotional video and presentations can be downloaded via www.modurban.org and www.unife.org.

ALSTOM Group seals Vietnamese Signalling & Telecommunications Contract

The ALSTOM Transport SA-Hasitect-ALSTOM Vietnam Ltd consortium on 5 December 2008 signed an EPC bidding package worth more than EUR 42.7 million (USD 54.6 million) to modernise the telecommunications and signalling system for the second phase of Vietnam Railway’s Hanoi-Vinh line.

The upgraded section, part of the Hanoi-Ho Chi Minh City line, is 319 km long and includes 36 train stations. “Upgrading the line to satisfy domestic demands for transportation in the future is absolutely essential because transport density and railway transport through capacity here are so high,” said Vietnam National Railway General Director Nguyen Huu Bang.

The project was approved by Prime Minister Nguyen Tan Dung and funded in 2005 with a EUR 40.3 million loan from the French Ministry of Finance’s Treasury and Economic Policy General Directorate (DGTPE). The two-phase project has a total cost of EUR 51.3 million, of which about EUR 11.1 million is being paid by the Vietnamese Government.

The project will replace out-of-date telecommunication and signalling systems on the Hanoi-Vinh section of the transnational railway to improve the capacity, quality and safety of rail transportation.

Project Director Tran Van Luc said that the contract would cover surveying, technical planning, cost estimates, training and other elements of the project. The French Embassy first trade counsellor, Guillaume Rousson, said, “DGTPE and the France Development Agency has sponsored EUR 142.5 million for Vietnamese Railways since 1990, proving it is a special concern of the French Government for the modernisation of Vietnam.”
Tube Lines gives Neasden control centre a full makeover
Next step in Jubilee line upgrade begins

It was announced in late November 2008, that major changes are afoot at the Jubilee line control centre at Neasden, from where London Underground employees manage train services. As part of the line upgrade which will mean faster, more frequent passenger services, Tube Lines is starting to completely refit the control centre whilst ensuring it can keep running 24/7.

The Jubilee line is currently controlled from two centres, one in Neasden depot and one at Baker Street. A detailed work programme will overhaul the Neasden centre so that the service control team can manage the whole line – from Stanmore to Stratford – from a single location, a significant improvement on the existing split set up.

New technology and desk layouts will make Neasden one of the most advanced line control bases in the world. Instead of a classroom layout which is typical of control centres, service controllers will sit in a circular layout to ensure they can easily communicate with each other. This better arrangement and their new multi-functional desks will enable them to flexibly oversee smoother services and respond more effectively should problems arise or incidents happen.

The focal point of any service control centre is the overview display, which shows details of what is happening along the entire line. Most centres use a single bank of screens at the front of the classroom layout. The new circular formation is made possible through using flat screens suspended from the ceiling.

Tube Lines and London Underground have worked together closely to design the most effective control centre to satisfy Jubilee line operational needs. They have carefully planned the refit to ensure that the London Underground team can continue to oversee daily services throughout the work.

Conrad Fawcett, Senior Project Manager at Tube Lines said:
“It’s a tough job to completely refit a live control centre, but our careful planning and the teamwork we’re seeing from London Underground mean we are confident all will run according to plan. When the changeover is complete, service controllers will have a state-of-the-art base to provide the best passenger services.”

Paul Kilius-Smith, Head of Operational Upgrades at London Underground said:
“The line upgrade being delivered by Tube Lines will enable us to provide passengers with faster, more frequent services. The London Underground service control team face a challenge in continuing to do their jobs ‘Keeping London moving’ while upgrade work goes on around them - the combination of their professionalism and thorough planning by all involved gives me confidence that all will go smoothly.”

Work started in late November 2008 and will finish this year. The Jubilee line upgrade will be delivered by Tube Lines by the end of 2009, using a Thales moving block train control system.
Fault Tree Analysis

By Nigel Handley

There is no mistaking that Reliability, Availability, Maintainability and Safety (RAMS) is now integral to many railway projects, both scheme and product related. Whether you believe that to be good or bad (a debate for another day!), the tools and techniques associated with RAMS analysis need to be understood and are worthy subject matter for Technical Tips articles. To this end, this article has been prepared to provide some assistance to those working with or interpreting Fault Tree Analysis (FTA), particularly those who may be encountering it for the first time.

FTA is a graphical technique developed in the 1960s, that systematically describes through logic gates (AND, OR, etc.) combinations of faults/occurrences (events) in a system that can result in an undesirable outcome (the Top Event). FTA is both useful to gain a pictorial insight into the ways in which system failures can arise and to allow quantitative assessment of the probability or frequency of a hazardous outcome/ scenario. This is particularly relevant where assessing risk or demonstrating compliance to a quantitative safety target.

AND/OR gates are the most commonly used in Fault Tree construction. The mathematical expressions associated with these gates are as shown below:

\[
Q(C) = Q(A) + Q(B) - Q(A)Q(B)
\]

\[
w(C) = w(A) + w(B)
\]

Where Q represents probability (unavailability) and w represents failure frequency.

In all calculations, a failure frequency can never be multiplied by another failure frequency, as the units would be inconsistent.

Identify all credible failure modes first
Failure Mode and Effects Analysis (FMEA) or Hazard and Operability Studies (HAZOPs) are typically used for this. Such studies also provide a better insight into the way the system works. Some failure modes might not be analysed through the FTA if they are deemed to be incredible, but any such assumptions should be recorded. It may still be prudent to include these failure modes in the FTA, but with no data, to show that they have been considered, unless doing so requires disproportionate effort.

Get the Fault Tree structure right at the outset
This is project dependent, but it is often most useful to produce a hierarchical tree that systematically works top-down from the point in the system at which the Top Event is realised. This doesn’t always make for the smallest tree, and can sometimes mean a lot of repetition (e.g. a single point failure may occur in numerous legs of the tree rather than having a single occurrence at the top of the tree). However, the approach is more systematic, less error prone, and the resulting tree can be more easily checked and updated for future design changes. Single Point Failures (SPFs) and other low order failure combinations can still be easily deduced through modern Fault Tree software.

The simple lower example opposite shows this hierarchical structure. Event E7 is repeated in both legs of GATE3, but could be moved to a single instance under GATE2. Fault Tree software takes into consideration the repeated event, but if performing calculations by hand, the Event E7 would be only considered under GATE2 to avoid double counting.

Data sources
The most robust data available should be used to populate the Fault Tree. Generally speaking, in-service data is usually the best, but often data is also assigned on the basis of supplier information, assumed equivalence to other systems/components, or recognised industry values. Where no data sources are available, it may be necessary to assign data on the basis of engineering judgement.

If human interfaces apply, Human Factors techniques may be required to estimate values for human error. It is important to realise that when performing a quantified analysis, the end result is only as good as the data entered. Because of the general lack of verified data, quantified Fault Trees are often used to determine the effects of changes to systems, not obtain absolute values.

Initiators/Enablers
In certain circumstances, the order in which events take place must be considered to evaluate the Top Event failure frequency. In the upper example opposite, the protection (GATE1) must have failed before the demand is placed on it (ATP EB). In this case, ATP EB is classed as the Initiator (the last event in sequence) and all events under GATE1 are Enablers. The AND gate mathematical expression above is adjusted as follows:

\[
w(TOP1) = w(ATP EB).Q(GATE1)
\]

When to stop modelling!
In large/complicated systems, the possible failure combinations can sometimes seem endless. If the additional effort yields ever diminishing returns (i.e. a relatively insignificant value for the failure frequency and/or probability), then it may be time to stop with an Undeveloped event. The diamond-shaped symbol for this is shown in the example opposite.

Common Cause Failure (CCF)
The potential for CCF should always be borne in mind. If an event can result in two or more failures within the system, this is best treated in modern Fault Tree software by multiple instances of the same event. Where two or more separate failures may arise from a common cause (e.g. EMC, environmental or batch related effects, etc.), then these can be linked in the model to show the dependency. The Beta factor model is the simplest and most commonly used method for dealing with these CCFs. This assumes that a fixed proportion of the failures arise from a common cause (e.g. a Beta factor of 0.1 indicates that 10% of failures are due to the common cause).
### Sensitivity Analysis

Sensitivity analysis allows event data to be adjusted to determine what the effect on the system parameters would be. It is particularly useful where the data for an event is ill-defined but known to be within certain bounds. This analysis can be quite simple or extremely involved. The level of effort applied to the sensitivity analysis should be commensurate with the level of risk and confidence in the assigned data.

### Interpreting the results — the numbers game!

It is important to recognise that FTA, like anything else, is just a model based upon a series of assumptions. For example, the model may include a SPF with a rate of 1 failure per 100 000 hours, yet in reality, the next failure may be just round the corner. Also, it is not guaranteed that all failure combinations have been deduced. Therefore it is important to always stand back and don’t ever let the numbers game be a substitute for sound engineering judgement.

If a system has a SPF that doesn’t look right, try to eliminate it or at least ensure it is managed. And a further note, make sure you document and justify all your assumptions!

### Next steps

It is sometimes necessary for the data underpinning the FTA to be fed into other work streams. For example, if a probability of failure has been deduced from a failure rate coupled with an inspection interval, the assigned inspection interval can form the basis of a maintenance task.

A Top Event may also form the initiating event for Event Tree Analysis (ETA) (watch out for future Technical Tips). This follows the event through a serious of possible paths to determine the different outcomes (consequences). Each path is assigned a probability of occurrence so that the parameters associated with each consequence can be assessed.

### Further Research

There is a wealth of comprehensive information in the public domain that describes Fault Tree construction and the theory behind it in detail.

Two good places to start are:
**New Head of SBB Infrastructure appointed**

The Board of Directors of Swiss Federal Railways SBB AG has appointed 53-year-old Philippe Gauderon, a French-speaking Swiss, as the new Head of its Infrastructure Division and a member of the SBB Management Board. The current Head of Infrastructure, Hansjörg Hess, has decided to scale back his activities: he will be taking on specially assigned tasks within SBB. Manfred Haller is to take over as Head of the Operating business unit of the Passenger Division, Philippe Gauderon’s current post, on a temporary basis. These changes took effect from 1 January 2009.

The 57-year-old Head of SBB Infrastructure Hansjörg Hess has decided to scale back his involvement in the company and so to step down as Head of Division. Hess, who has been Head of Infrastructure since 2004, also relinquishes his membership of the Management Board of SBB AG. He will continue to report directly to the CEO of SBB AG, Andreas Meyer, and will be assigned special assignments by him. These will include representing SBB AG on international bodies, technical consultancy services for important innovation projects and taking on directorships for SBB.

The Management Board and the Board of Directors of SBB AG would like to thank Hansjörg Hess for his outstanding services to the company and public transport in Switzerland as Head of SBB Infrastructure over the last four-and-a-half years. This period has included the successful repositioning of SBB Infrastructure and its continuous development within SBB, as well as the creation and introduction of the state-of-the-art train safety and signalling system ETCS as part of Rail 2000 and NEAT on the new high-speed line between Olten and Berne and in the Lötschberg base tunnel. A graduate in engineering from the Swiss Federal Institute of Technology, Hansjörg Hess has been the driving force behind the new strategic direction and technological development of SBB Infrastructure in recent years. Under his leadership, the Infrastructure Division has become a customer-focused service provider for all railway companies using the SBB network.

His successor as Head of SBB Infrastructure is Philippe Gauderon from French-speaking Switzerland, who until now has been Head of the Passenger Division’s Operating business unit. At its latest meeting, the Board of Directors of SBB AG appointed the 53-year-old from Fribourg to his new position and also made him a member of the SBB Management Board.

After qualifying as a state-registered lawyer from the University of Fribourg in 1983, Gauderon continued to work in his specialist area in his home town from 1983 to 1985. Between 1985 and 1995 he held numerous senior positions at the Swiss Federal Office of Transport (FOT), including that of Deputy Director from 1990 to 1995. Gauderon joined SBB on 1 January 1996 as director of what was then district 1 in Lausanne. When SBB was restructured as part of reforms to the rail system in 1999, Gauderon took over as Head of regional services in the Passenger Traffic division, where he was also a member of the divisional management board. Since October 2003, Philippe Gauderon has been Head of Operating and Deputy Head of the SBB Passenger Division. This business unit, which has 6200 employees and an annual budget of CHF 1.3 bn, is responsible for the 5500 trains that SBB’s Passenger Division runs every day: from Purchasing and Supply Chain Management to planning and managing production, train preparation (cleaning and marshalling) and train driver services, to the maintenance of rolling stock.

Philippe Gauderon is married and has three children. He lives with his family in Canton Fribourg.

On 15 December 2008, Invensys Rail Group (IRG) appointed Ala Ghanem to Head of Business Development (Middle East).

Ala Ghanem has been acting as an Agent for IRG in the Middle East for the past two years. He will be located at an IRG office in Dubai serving the Middle East and North Africa.

James Drummond, President and CEO, IRG says “The role of the Head of Business Development (Middle East) is important as its part of IRG’s strategy to provide a regionally based focal point for business activity across the Middle East region.

This position marks a return to living and working in Dubai for Ala, who previously left the country in 2001 to take up a position in Melbourne, Australia.
Merit Award

It is not often that Peter Woodbridge is speechless, but he was surprised if not totally speechless when, during the Younger Members’ seminar at Birdcage Walk, London on the 15 January, Alan Fisher, the President, pre-empted Peter’s talk on the IRSE exam forum and the exam website by presenting him with an IRSE Merit Award.

The room had many people in it who had benefited from Peter’s help over the years with exam study groups and most recently with preparing support material for Module 2 of the examination, Signalling the Layout, and the President cited all this support work as the reason that Council made the award. The nomination had been made last year by one of the students who had studied for the exam with Peter’s help and had been able to pass the required four modules in a two year period.

Colin Porter

New Indian Section

As previously announced the Institution has been considering the formation of an official Indian Section. Good progress has been made and this photograph was taken at the meeting of the working group set up to establish the Section. The picture was taken at the Conference Hall of Rail Bhawan, New Delhi (The Indian Railways HQ) on 4 December 2008.

The gentlemen in the photograph from left to right are:
- Sh. R.L Dam, Executive Director/Eldyne,
- Sh. K.K. Bajpayee, Group Jt. MD/McML,Chairman,
- Sh. V. Balram, Director/IRISET
- Sh. Chandrika Prasad, MD/CNPS
- Sh. Arvind Gemji, Director/Kalindee Rail Nirman,
- Sh. G.G. Bhawas, Consultant/Kolkata Metro.
- Sh. Anshul Gupta, GM/RCIL

In the background, partly hidden, is the painting of the railway coach in which Mahatma Gandhi travelled on Indian Railways.

The inauguration of the section is planned to take place in Secunderabad on Monday 16 February 2009, and will be attended by the President, Alan Fisher.

Thanks to Chandrika Prasad for supplying the photograph and this information.

Colin Porter

Dutch Section

As described above, good progress is being made with the setting up of the new Indian Section. In parallel, progress has also been good with our colleagues in the Netherlands, who started slightly earlier, in setting up the Dutch Section. All the legalities have now been settled and the picture shows those members who attended the first Section Committee meeting.

From left to right: Arjan Førrer, Kirsten Luiten-Loeff, Peter Musters, Marco Jungbeeker, Maarten van der Werff, Henk Scholten, Jan Oonk, Ton van Rijn, Peter Otten (and on the laptop Wim Coenraad!)

Colin Porter
Midland & North Western Section

The Section committee meeting was followed by an exciting evening presentation, which was held on Wednesday 3 December 2008 in the Unipart Rail Offices in Crewe.

The Section Chairman, Melvyn Nash, introduced and welcomed Stuart Baker, Deputy Director of Department for Transport, responsible for UK rail projects outside London. He then invited Stuart to present his paper on “West Coast Route Modernisation 2002-2008 and what next”. Stuart started his presentation indicating commitment of huge investment on rail projects during next control period to develop UK railway and also highlighted the possible announcement on further investment within very near future. Stuart illustrated the background, objectives and key achievement of “West Coast Projects” and mentioned about the aspiration of future projects. He mentioned the success of the West Coast projects, economic growth even before completion of the projects and impact on December 2008 timetable.

The West Coast Route involves about 2671 km which connects many key UK cities, key passenger routes with mixed commuters and one of the busiest trunk routes in Europe. The key objectives of the West Coast Route modernisation project were to:

- Address the major backlog in maintenance and renewals;
- Establish sustainable and cost effective maintenance regimes;
- Provide capacity for growth of passenger and freight business over next 20-30 years;
- Improve safety and reliability performance and hence dependability;
- Achieve all above on a working Railway.

Stuart highlighted the success of key West Coast projects as Milton Keynes Central remodelling (due to be commissioned on 27/12/08), Rugby Resignalling (commissioned on 31/11/08) and Trent Valley four-tracking with wide spacing (commissioned during August 2008). Commuters will see the benefit of these projects with the introduction of new timetable on the 14 December, 2008.

While comparing the success against the objectives, high-level achievement of West Coast projects up to 2008 can be summarised as follows:

Achievement:

- First stage commissioned South of Crewe - September 2004;
- Improvement on North of Crewe – 2005;
- Reliable service from Monday to Friday. Traffic on intercity services doubled since 2003/2004;
- Commitment to achieve a trebling of passenger and revenue growth during 2003-2012;
- Delivery of work by 14 December 2008.

Dependability:

- Pendolino Train achieving traffic target;
- Tilt is very reliable (>99%);
- Lesson learnt from SBB ICN train;
- Infrastructure renewals delivering reliability.

Economic Growth:

- Regeneration areas around stations;
- Improving link between London and major cities;
- Made business travel easier and quicker;
- Revenue growth compared to other lines.

Impact on December 2008 timetable:

- All routes faster by 5-10 minutes;
- 20 minute interval service between London and Birmingham;
- 20 minute interval service between London and Manchester;
- Faster Liverpool, Preston, Glasgow services by up to 20 minutes;
- Extra peak services;
- Improved freight capacity.

Stuart then clarified the proposal for further capacity increase of the route post 2008. He mentioned about future challenging projects of Stafford remodelling, Crewe - Chester electrification, Crewe - Motherwell re-signalling and Freight looping capability. He presented the constraints of Stafford area and possible solutions either through a bye-pass or grade separation within the existing infrastructure.

In conclusion, Stuart narrated the value from West Coast Project as the forecasted passenger level to be trebled from 2004 to 2012 with strong economic return. Despite the high cost, it is now projected to have cash positive effect on Government. The project will also add value to the dependability as a seven day railway with enhanced route capacity, which will have an economic effect on regions. It is also realised a major modal shift in domestic air market and provide a good artery for freight traffic growth.

Stuart answered many questions raised by the Engineers present. Melvyn gave vote of thanks for a very informative railway development strategy paper. He also extended his thanks to Unipart Rail for the arrangements of the day.
York Section

The Chairman, Andrew Smith, welcomed 39 members and three guests to a revised Technical Meeting at the Bar Convent, Blossom Street in York on Wednesday 3 December 2008. The Section was very grateful that Messrs Alan Lowe and Alan Barker of WRSL were able, at short notice, to present their paper “Lincoln Signalling renewals and Track Remodelling Project”.

Alan Lowe began by outlining the area covered by the Project from Saxilby in the North West, Langworth in the North East, Swinderby in the South West and Blankney in the South East. The history of each signal box was discussed with the history of Lincoln Station which opened in 1846.

During 2003 a re-signalling scheme was developed in conjunction with proposed track renewals. However track funding was then withdrawn due to the need to address more urgent sites at the time and this resulted in the re-signalling scheme being shelved until such time as there was appropriate joint Permanent Way and signalling funding. Network Rail continued to provide funding for signalling renewals in the area, the largest of these being the rewiring and conversion of a number of low voltage track circuits to medium voltage from West Holmes to Swinderby and Saxilby.

Major Permanent Way alterations could not be supported by the existing signalling equipment and therefore the signalling renewal had to be carried out at the same time as the proposed Permanent Way alterations. The various layout criteria that demanded resolution at Lincoln were difficult to reconcile. The site is relatively constrained and the access at both the East and West ends couldn’t be opened out to give anything other than the existing two track access without major land acquisition and rationalisation. The track layout therefore had to be decided on the basis of flexible working in a constrained layout. Any risk of collision had to be risk managed primarily by the best possible track layout design and signalling controls.

The main changes were the new interlockings would be SSI with Dorman LED signals and route indicators. The control and indication system is a WESTCAD. Train Detection would be by axle counters between Langworth and Blankney through the station to West Holmes Junction and by track circuit with conversion of a number of low voltage track circuits to medium voltage from West Holmes to Swinderby and Saxilby.

A new lineside 650 V signalling supply was provided which was centralised at the LSCC before being fed out as individual feeders to the various trackside locations. Interfacing with other signalling interlockings at the fringes was required but alterations were kept to a minimum as the future proposals for the area include closure of these fringe signal boxes.

Future plans for South Lincolnshire include provision in the new LSCC for the future control of areas covered by the following signal boxes: Stow Park, Saxilby, Swinderby, Blankney, Holton-le-Moor, Wickenby and Langworth. The numerous level crossings on the project were dealt with by converting High Street Level Crossing to CCTV and transferring the control of the other Lincoln area CCTV crossings, Sincil Bank, Brayford, Boultham and Doddington Road, to the new SCC. Hykeham and Kesteven AHBC’s would have their monitoring point transferred to the SCC and Rushtons Tip MWL was to be converted to MSL. Due to the size and number of fringe routes reading into the new Signalling Centre it was necessary to provide a train describer (TD) with Fringe Box units provided at the fringe Signal Boxes. Swinderby already having a fringe unit to Doncaster TD was fitted with a small TD unit automatically passing train descriptions from Doncaster via the Swinderby area on to the new Control Centre.

The work was completed in two blockades one from 11 August to 3 September 2007 with the final commissioning taking place from 18 July to 1 September 2008. There were a number of incidents during the completion of the lineside Civil Engineering ground works. The most serious being the use of a strap to lift a signal structure ladder instead of a chain which broke and resulted in a serious injury to a member of the construction team.

So in conclusion after the six-week shutdown, the former mechanical signalling stronghold has been brought into the twenty first century with an ultra-modern signalling and control centre with room for expansion; there is also brand new Permanent Way with much more flexible layout including bi-directional working, the closure of four signalboxes boasting an average age of 132 years and removal of one of those rare examples of a station with a box at either end. Also gone was one of the shortest block sections, the 200 metres between East Holmes and High Street.


The Vote of Thanks was given by Sean MacDonald of Siemens who sponsored this meeting.

Andrew P Smith
Scottish Section
Annual Dinner

Last year’s Scottish Section Annual Dinner took place on the 13 November 2008 in the Marriott Hotel in Glasgow. The event, organised by Peter Allan and sponsored by Parsons Brinkerhoff, saw the largest attendance to date. Almost 200 members and guests attended, with 15 Scottish companies buying tables for their guests.

The dinner started off with a few aperitifs in the bar which gave guests a chance to catch up and relax before the meal.

As is customary for the Scottish section, last year’s IRSE President, Wim Coenraad, was invited and joined Richard Lockett (guest speaker) and Ron McAulay, Network Rail’s Director for Scotland, on the top table. After the meal Alistair McWhirter, Scottish Section Chairman, presented Ron and Richard with IRSE ties to thank them for their efforts. He then passed the microphone on to Ron who gave a humorous after dinner speech on his previous experience working with a utility company before outlining the challenges that face the rail industry as a whole.

After the meal and speeches, guests took the opportunity to catch up with old acquaintances before again retiring to the bar, no doubt to discuss some of the topics raised throughout the evening.

The Section would like to take this opportunity to thank Peter Allan and the Marriott Hotel for organising the event. Special thanks also go to Parsons Brinkerhoff for sponsoring the dinner and the individual companies by supporting the section by buying tables. The proceeds from the event go towards paying for the rest of the year’s meetings ensuring that they remain free for the Section members.

Stephen Wright

The UK Young Scientists and Engineers Fair 2009

Following the success of a similar event in Dublin, a UK Young Scientists and Engineers Fair will be held in the UK on 4-6 March 2009 at the Queen Elizabeth II Conference Centre, Westminster, London.

The ambition is that the Fair will be a focal point for the efforts of the science and engineering community to excite and stimulate young people. Through the range of exhibits, workshops and events at the Fair it is hoped that young people will discover the huge range of opportunities that exist for those with science and engineering qualifications in the UK and encourage more young people to take part in science and engineering initiatives with support from their parents and teachers.

The Fair will allow regional finalists of the BA (British Association for the Advancement of Science) CREST Awards, and Young Engineers for Britain to exhibit their award winning project work alongside other entrants for the newly established National Science Competition. Those exhibiting at the Fair will compete for a range of existing prizes and for the National Science Competition. A high profile, celebrity led, awards ceremony will be the highlight of the Fair where the winners will be announced. Inspirational and challenging lectures, shows, workshops and presentations across the entire science and engineering spectrum; displays and demonstrations of leading edge UK technology; and exhibition stands to showcase other science and engineering projects and schemes are also planned to make this a truly creative, innovative and inspiring event.

A large number of organisations have been involved with the planning and implementing of the Fair, including, amongst others:

- Engineering Development Trust
- Mathematics in Education and Industry
- Natural History Museum
- The British Association for the Advancement of Science
- The Engineering and Technology Board
- The Institute of Physics
- The Institution of Mechanical Engineers (representing the professional engineering institutions)
- The Royal Academy of Engineering
- The Royal Society
- The Science Museum

In addition, a large number of organisations have already committed funding to support the Fair involving some commercial companies and all the major engineering Institutions, including the IRSE.

The Fair will be a true experience to remember for young people. Activities, workshops, interactive shows, and exhibits are all being designed with this in mind. Demonstrations that amuse, inspire and amaze; smaller workshops where young people get a chance to get their hands dirty; interactions with real engineers, scientists and entrepreneurs; along with chance encounters with science and engineering entertainers will all form part of the rich tapestry that will be the UK Young Scientists and Engineers Fair in 2009.
Feedback

Curiosity Corner

'Curiosity Corner' in Issue 140 of IRSE NEWS showed new colour light signals in Austria with their heads lit and turned away from the track prior to commissioning. The enclosed photograph was taken in the UK and will, I hope, make an interesting comparison. The picture shows the east end of Springburn station in Glasgow on Christmas Eve 1998, one day before work began to commission new signalling controlled from Cowlairs Signalling Centre. New signals CC323 and CC407 (the latter facing away from the camera) are seen lit and unmasked but laid on their sides so as not to obscure the existing signals S67 and S92 (on Platforms 2 and 3 respectively). Their red aspects are shining towards lines that are open to traffic and to which the signals will apply once brought into use. Platform 4 had been temporarily put out of use two weeks before the commissioning, allowing the new signal CC409 (seen in the background) to be mounted on its base and lit, albeit hooded, and the old signal S93 recovered.

An alternative solution that facilitated early erection and pre-testing of a new signal without it obscuring the old one behind was to mount the signal on its base, suitably wedged so that it would lean to the side. The new signal head must then be hooded until commissioning, when the wedge is taken out and the signal post properly secured to the base. Needless to say, it is preferable to avoid such complications by not positioning new signals in front of existing ones wherever possible.

Simon Lowe

Level Crossings Again

To continue my theme in Issue 139, as far back as I can remember, the subject of level crossings has ever been a ready source of debate and argument. If an accident occurs at a crossing, the world is filled with instant experts and the media have a field day! The most serious accident in recent memory was at Kerang, Australia, in June 2007 where 11 people were killed and 23 people injured when a lorry was driven into the side of a passing passenger train.

The lorry driver was immediately arrested and his case will be heard in the Victoria Supreme Court, in Feb 2009. (Search Google, “Kerang accident” for the details)

After a brief talk with him recently, I do not think my views are a million miles away from those of Peter van der Mark but there are areas where we must agree to disagree. If all the various types of crossing are included, the majority of the world’s level crossings are unmanned and unsupervised. In normal circumstances, for all practical operational purposes, they are transparent and ignored.

Some of these may have warning lights, with or without half-barriers, but many have nothing more than a notice board or a post bearing a fixed diagonal cross. There is an assumption that the road-user will take care and keep a sharp lookout in the latter cases.

 Worldwide, reliance is placed on the road-user to behave sensibly and to obey any warning signals provided. After all, drivers are expected to obey normal road traffic signals - and the majority do.

However, the foolish minority fail to recognise that ignoring the warning lights at level crossings can be fatal - which is not necessarily the result of ignoring or “jumping” a red traffic light!

In an attempt to raise driver’s awareness of level crossings and the dangers represented, there is currently a TV campaign in UK but these “adverts” are brief and infrequent. It is to be hoped that these will continue but at greater frequency and it is to be hoped that such films will be shown in every driving school across the country.

It is perhaps of interest to include an excerpt from a recent edition of a Paris newspaper: “As part of the plan to improve safety at level crossings, some 60 radars aimed at controlling car speeds will be installed on the most dangerous of these sites. Meanwhile, 17 machines will be set up across France in the coming weeks. Other sites will be the object of technical feasibility studies before radars can be installed”.

To conclude, the ever-increasing and slavish use of “satellite-navigation” in vehicles, may present further areas of risk in the future as drivers are “directed” on to unfamiliar or unsuitable roads. There has already been a case of a woman unexpectedly finding her car blocking a level crossing - “It was not my fault; I was following the sat-nav”, she said.

Monish Sengupta

Research

I have received Issue 141 of IRSE NEWS. I have been asked to send my comments regarding the front page fonts. First of all thank you very much for noting my comments. Secondly I must say the fonts are great now.

May I add a further comment? There are enormous researches going on in the field of Railway Signalling in UK as well as in Europe. If IRSE can capture those and involve more and more Signalling Engineers in the research activities, it will open up a new dimension in our Signal Engineering Industry. Let us think beyond the IRSE licences for professional development of Signal Engineers. Personally I struggled to find a guide in London to carry out my research. I have a vision of opening this branch of Engineering at least for research activities in top Universities in London.
An Interesting Concept

I will not be widely known as it is now quite a number of years since I left BRHQ and even more years since I was an Associate of the IRSE. A month or so ago, I had a discussion by email with Ken Burrage. He suggested that I throw open this discussion to a wider panel through the IRSE NEWS. Please let me explain - I hope not in too many pages!

Most of my career was at BRHQ. I left BR in July 1985 to continue as an independent consultant until 1997 when I finally retired. Between 1968 and around 1981, when the BRHQ Level Crossing section of the Chief S&T Engineers Department was closed down, I was responsible for all Level Crossing matters as well as for most of that time for Automatic Revenue Collection and Car Park systems. Between 1981 and 1985 I was in the BRHQ S&T Project Team servicing the requirements of Transmark - a wholly owned subsidiary of BR.

During my service at BRHQ I was responsible for the development of all level crossing policy and equipment, including the development of the current protection systems. In March 1971 I presented a Paper to the Institution in London, and at a number of provincial centres during the same year. The Paper was entitled ‘Modern Developments in Level Crossing Protection’ and its purpose was to spread knowledge of the changes brought about by the Accident at Automatic Half Barrier Level Crossing at Hixon in the then London Midland Region of BR. A secondary purpose was to envisage the future of this rather specialised branch of Signalling. In 1976 I was a member of the Joint BR/Dept of Transport Level Crossing Working Party from which most modern level crossing practice comes.

I was fortunate enough to have had a very interesting career in which I was responsible for the development of many items of equipment (some of which I believe are still standard) and for the development of policy, procedure and principles in all aspects of level crossing work. A great deal of my work was well beyond the boundaries of conventional signal engineering.

In 1986 I gave a Paper entitled ‘Road Safety at Level Crossings’ to a joint Anglo-Hungarian Road Safety Seminar in Budapest. This paper was effectively an up-to-date review of level crossing protection, giving an overview of what had transpired in the field since 1971. I gave this paper several times after that time - the last documented time being at the 1990 Second Railway Industry Signalling Course at Derby.

I have recently re-read both of the papers and believe them to be a fair representation of what has happened over all the years between 1963 (when I first became engaged on level crossing work) and the present time. I think the fundamental principles, practice and policies I tried to set out then hold good as well today as they did at the time of writing.

A few months ago, I happened to notice that the Rail Accident Investigation Branch (RAIB) were embarking on an investigation into Private Level Crossings - a subject of considerable interest to me and one on which I had prepared a paper for Northern Ireland Railways some years ago. The proposals I made at that time did not proceed because of lack of finance and the paper went, with some other papers of mine into the IRSE Archives, thanks to kind help from Ken Burrage, an old friend and colleague.

I offered sight of this paper to RAIB and I believe they did borrow it; they certainly thanked me for it. I haven’t seen their report yet but these things take a long time. I have always had a great desire to somehow resolve - or at least improve the very challenging Private Crossing problem and, although I had put railways and level crossings into the back recesses of my mind, this RAIB matter re-awakened my interest. Additionally, where I now live in Kelowna in British Columbia, I can perceive the possible benefits to the City of an ‘on street’ tramway system and these two matters caused my ‘little grey cells’ to become active again.

I have at last got to the point! Below, I set out the essentials of the emails between Ken and me about the tramway possibilities and I am inviting the views and reactions of IRSE NEWS readers to my thoughts.

In Kelowna there is a long siding (about 100 miles, 164 km) from the main Canadian National (CN) line at Kamloops which services Kelowna’s rail terminal for timber and fruit etc. I had been wondering about the possibility of a tramway system for Kelowna making use of the CN track which is not used very much. It seemed to me that given a reasonable overall control system which CN would manage, coupled with an adequate number of passing loops, CN trains and modern trams (with a ‘stop on sight’ capability) could safely use a common track.

Ken responded by referring to the vast difference in crash worthiness and that a practical proposal would need to explain how it would be impossible for a conflict between train and tram to occur. A scheme where the trams use the track during the day with no other traffic allowed on the line and the freight trains use the track in the night when the tram service has stopped is one practical method that minimises control costs as the trams use the line under possession (as it were) and they can drive on sight so only minimal signalling is required.

Clearly, the risk of having a real train hitting a tram is a pretty daunting problem and one to be avoided at all costs - so a very positive and highly reliable solution would have to be found. It is too easy to say divide the traffic between night for real trains and day for trams. That would work of course but not many railway operators would like the idea much, and even then, it’s not foolproof. I have been thinking about the subject and wonder if there is the germ of an idea in the following scenario.

1. Consider a system in which a ‘joint’ line is under the overall control of a signalman (or whatever they call them these days) and that signalman – or the traffic processor he oversees - has a perfect picture and full control of the exact location and movement of each and every train or tram on the system - moving or stationary.

2. This perfect picture would be derived from GPS transceivers on each train/tram which would require concurrence between the transceivers to agree the location of the train/tram. The trainborne equipment doesn’t have to be part of the train but part of the driving mechanism, e.g., key or control release etc, the driver needs to operate his unit.

3. At certain locations - depending upon the nature of the joint line etc - there would be passing loops of adequate length to accommodate several trams - trams can and often do bunch up and the facility of being able to stop on sight permits this - relying as it does anywhere in the system on tram drivers to behave themselves properly, or even better, control mechanisms which force them to do so.

4. The loops would be arranged such that, like the automatic passing loops I think I remember on the Ipswich-Lowestoft branch, adequate traps are provided at each end. The area
around the trap points would require to be track circuited to avoid the risk of points moving under trains/trams but otherwise there would appear to be no need for track circuits on the joint line.

5. All trains/trams would be in communication as required with the signalman with the best of modern communication equipment which, again, would have to have several channels each having a capability to lock on to the train/tram being controlled throughout the time it was in the control zone.

6. All these various aspects would require to be incorporated into software which would enable the signalman to direct trams into appropriate passing loops to enable the passage of real trains. Once trams were ‘inside’ the real train - at some distance still - can be directed to continue to approach (some passing loops might also serve as stopping places for the trams).

7. As and when the train passes waiting trams, they can be released either to go in the direction from which the train has come or even to follow the train - with the facility to stop on sight of the rear of the train - this should not present a significant risk.

8. Clearly 'the devil lies in the detail' but, as I see it, it should be possible with modern software to be able:
   (a) to show the locations and identities of all trains/trams - as they move and as they stand on a real time basis - on a line diagram (or whatever they are called these days) as well of course as the location of the loops and stations etc.
   (b) to devise a system in which the onboard and signal box processors must agree with each other and, once directions given be incapable of change until the signalman releases the system. It follows of course that everything must be recorded in real time.
   (c) to provide for the system at (b) to be able to render inoperable the driving system of a tram directed to wait until the release is given.

As I see it, one of the biggest problems of sharing a common track - discounting the main risk of collision - is the understandable desire of the train operator to have clearance much earlier than perhaps such a system as I describe might cater for.

It seems quite possible however for the trams to ‘pop in and out’ of passing loops as the train proceeds, provided always that the train is given sufficient headway (if I may borrow the term) for it not to have to stop.

It follows of course that on occasions it may be inconvenient to the tram operator to have to submit to laying a tram or trams aside while the train passes but, with modern on-board information systems, the passengers in the trams and/or waiting at tram stops can be kept adequately and accurately informed.

I outlined these ideas to Ken who responded again by saying that a system such as I had described was certainly feasible and that all the technical elements are readily available. The main problem would be to find an acceptable (to the safety authority) explanation of what happens to cope safely when there is an equipment failure. The usual approach is to explain that the system is used for (typically) lightly used lines where the train traffic is sparse and the calculated risk of catastrophic failure occurring at the same time as a train and tram are closely approaching each other is sufficiently remote as to be incredible. Safety authorities are usually not enthused by this type of explanation. He also remarked that another problem would be to develop a satisfactory business case for the investment. The equipment and software would have to be designed to meet Safety Integrity Level 4 (the highest safety level). That is expensive, and the amount of redundancy included to ensure reliable operation will also make a scheme expensive. The market is small and has not, up to now, interested the main suppliers.

He also suggested that I send my ideas on this topic to IRSE NEWS as the wider IRSE membership would be interested in the subject.

So, that is the email correspondence I had with Ken and after thinking about his last reply, I have thought about the future and also become aware of a scheme in Australia for driverless trains on a line with level crossings and my little grey cells lurched into overdrive! This lead me to the realisation that if I was thinking about a Paper today, I would be able to draw on advances in technology which were not available - or even thought about when I was in the profession.

I think I would take the view that the basics of level crossing protection need very little adjustment as most problems with this aspect result from the behaviour of road traffic, virtually beyond the reach of the railway signal engineer. So my imaginary new paper would considerably revise my approach to the fundamentals of signal engineering. So, what are these fundamentals?

- To prevent trains colliding with each other and, so far as possible, any vehicle which may cross the railway.
- To know where every train is.
- To effectively manage and safeguard the operation of every train by controlling it as far as possible and setting inoperative routes for each.

Maybe I could think of some more fundamentals but to do this is not my aim. My aim is to review what we have always done and then to consider - Would we do it this way if we had known then what we know now? The answer to that question must be NO!

When I finished my Apprenticeship, National Service and a brief spell in New Works Installation, I went into the Drawing Office to commence the rest of my career. Just like my peers, I learnt many things which will never be forgotten and some aids to good practice which can best be described as ‘things to remember’ - the one I have in mind is this - *Before you change anything, ask yourself (a) why is it like this? (there must be a reason and it may not be immediately apparent) and (b) what will happen if I change it?*

Most of what we regard as good safe signal engineering has come about as a result of some accident or other (sometimes several of the same sort) - sometimes as a result of human error or even criminal intent and something had to be done to prevent recurrence. As time went on more and more sophistication has gone into the practice but now I ask myself - *What if we could start the whole business afresh?* If a system which knew the exact location of every train was available - why would we need track circuits? Perhaps only to make sure that points could not be moved under a train. Track circuits themselves - once the answer to almost every problem - revealed their approach to obsolescence some years ago with the advent of lightweight railcars etc and the realisation that they could no longer be relied upon implicitly.

If we had a system that could lock a unique communication channel between each train and a control office and control the train’s operating system - why would we want fixed signals, except perhaps at points for some special movements? Fixed signals have never been able to be
It will be recalled that many years ago Mr Dell of London Transport developed 'interlocking machines' which, so far as I remember, had a timetable programme processor driving a mechanical interlocking based on the WB&S Co 'K' style miniature lever frames. I believe he took the view that relay interlocking wasn’t as fail safe as the mechanical variety.

This led me to the thought that, if mechanical interlocking can be regarded as positive thus requiring no redundancy, why should not a software system be made to be positive? Redundancy adds cost and complication. In taking this view I suppose I am saying that the software and its associated hardware would contain its own safeguards, i.e., internal redundancy for want of a better term, rather than multiple systems polling each other and requiring a majority of these before action.

Why couldn’t this system take over control of the train itself - nothing new in that idea of course, the London Transport had ‘train stops’ and driverless trains a long time ago. The value of the removal of much of the human factor from the system in the LT case is demonstrated by the enviable accident statistics. These demonstrate the truism that most accidents are caused by people - very few by system failures!

We have all seen so called ‘model railways’ in which a simple processor does everything without benefit of fixed signalling and track circuitry. We have also seen, and most people will know much more than I about so called computer games in which all manner of complex manoeuvres are manipulated by children (of all ages). So, is there an affinity between the technology required to produce these so called games and technologies we might be able to employ if we started all over again?

The complexity of, and the level of reliability and repeatability, such games exhibit suggests that railway signal engineers are not the only ones able to apply extremely high levels of thought to generate procedures which will repeatedly and faultlessly achieve safe and satisfactory performance. Computer games are a ‘simple’ everyday application of advanced technology – we are in fact surrounded by such things in the modern world. Most ‘ordinary’ motor vehicles today are equipped with extremely effective safety systems – quite often of course the human driver can manage to circumvent many of them but, as signal engineers, we know quite a lot about human weakness. In extra-terrestrial systems the degree of reliability and repeatability must be second to none as failure cannot be easily rectified – if at all – and there can be little or no room for redundancy of equipment or polling of multiple units. Clearly the ideal doesn’t just happen - life is not like that. Evolution has to happen!

Looking back with 20/20 vision over the better part of two hundred years of evolution in our profession as I am now doing - and inviting you to join me – I arrive at the realisation that modern railway signalling has come about in a very tortuous way to satisfy the fundamental requirement of stopping trains from colliding with each other - and in my own case, to try to limit the possibilities (no better than that can be achieved) of trains hitting road traffic at level crossings. I must digress briefly to comment on the modern desire to quantify everything, including risk. Ken mentioned Safety Integrity Level 4 – the highest. I suppose we always did try to measure risk and we had a saying: - ‘If it can happen – it will’.

If, say, Brunel (perhaps the first signal engineer, although we don’t often think of him as that) and all those who followed him in our profession, had only been able to know exactly where the trains were and had been able to communicate positively with the drivers (or better still with the control system of the train), would we have been where we are now with the very expensive and complex systems that we rely on nowadays - which are still not fool proof, even though they are as fail safe as we can make them?

As Ken Burrage observes, the cost of development of the sort of system I imagine in my old man’s pipe dream would be considerable and perhaps could only be borne as an alternative to present day systems in the case of a new railway, and who as Ken said, would want to take the chance – so, here we are back to risk assessment. The pay-off, in my mind, is likely to be in the future for all railways as the renewal of existing systems becomes due and will be found in the non-provision of fixed signalling systems and reduced maintenance costs of such a system as I believe is a possibility. Think about it!

Tom Craig

**Botswana Resignalling**

When I opened the January 2009 edition of IRSE NEWS and read in the Botswana article the statement "...the replacement of a paper based train order system...", I was to say the least somewhat surprised.

In May 1992 I undertook an aid feasibility study for the United States Agency for International Development looking at upgrades to the signalling and communications systems of Botswana Railways. At that time there was installed between Gaberone and Francestown, a British Rail style RETB system supplied by GEC-GS. It was, I believe, a modified system in that the block authority could be picked up ‘on the fly’ at crossing loops (or ‘sidings' in local parlance). It was however perfectly functional when I rode on the locomotive of the Blue Train between the two towns.

What, I wonder, happened to the RETB system if by 2005 Ansaldo were faced with replacing a paper-based train order system? My guess would be that by then the system would have been, as a minimum 15 years old and that faced with the replacement of an increasingly obsolescent system Botswana Railways had decided to abandon it and revert to pen and paper. It may also have been that ALSTOM, faced with upgrading a ‘one off’ system could not justify the development costs on a commercial basis. Bob Barnard may know the answer.

Phil Rossignol

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**Crossword No.9: Solution**

- ARAST
- TAU
- SANITY
- DOWNES
- HSI
- IRON
- FRANCIS
- ROYDEN
- PE
- EK
- E
- R
- B
- E
- TR
- EXIT
- VR
- HR
- E
- L
- G
- CB
- IC
- AM
- E
- NT
- AT
- NY
Manchester South

In 1998, I was involved with the initial development of the Stoke Scheme and we were invited to go to Manchester to hear what was proposed for the Manchester South Project as, at that time, it was intended to “fringe” to Stoke.

When asked for comments at the end of the presentation, I remarked “I think you’re being very brave.”

In 1998, I was approaching almost 40 years in the industry, most of it on major schemes and I could not believe that a decision had been taken to introduce technology untried in this country on such an important section of the route, on a high profile production project, a key part of the WCML upgrade.

Ironically through a quirk of fate, in 2001, I became Signal Sighting Chairman for the Manchester South scheme and so I came to work with all those “Bravehearts”. Bruce MacDougall included, who had the task of salvaging something from that decision and who, in the end made it happen – staff in Railtrack, Network Rail, their Contractors and of course, Ansaldo all deserve credit for their efforts.

But firstly, I would like to follow up on a point in his letter where he mentioned the amount of lineside cabling required for the system, which reinforced my earlier view.

The photograph (right) shows some of the cabling at Wilmslow Station secured to the wall of Under-bridge 76 on the Crewe – Cheadle Hulme line. This is at the south end of Platform 4 and, if the platform is ever extended for 11 car Pendolinos, dealing with them may well have a significant financial impact on the alterations.

Wilmslow Station has four bi-directional platforms, i.e. eight signals, AWS, TPWS, several OFF & RA Indicators, TRTS, etc as well as Patrolman’s Lockout devices, etc. So it would require quite a few cables in any system - even SSI!

But never a “Wall Full” and oh, by the way, there is another full cable route on the Styal Line, i.e., going through Platform 1.

For many years, the drive to reduce the number of lineside cables on BR was unremitting with firstly, the introduction of remote control systems and finally SSI, where you can expect to find less than a dozen cables in a two track wayside route.

As for the signals, from my role as Signal Sighting Committee Chairman, the eye’s perception of the beam from an SDO signal seems far more weather dependent than a good SL 35 or an LED. On overcast days it is fine but on sunny days, you do have to know where to look to pick up the light when you are supposed to. It may be simply a product of the smaller lens relative to a BR head or an LED but, in a general sense, I feel that it is more demanding of route knowledge than indigenous heads.

Obviously, the Sighting Committee ensured that all the signals met the requirements of the sighting standards for the speed of the line and a lot of people put in a lot of effort to making them so. The scheme lost an opportunity to take advantage of the LED signal which, when coupled with the benefits of the ACC system which Bruce touches upon, would have improved the overall system considerably from the perspective of the end users - Operators and Drivers alike.

I suppose the end of term report should say – should have listened more attentively to earlier lessons and could have done better!

Alan Joslyn

Skills Gap

I am sure that many colleagues will share the concern at the situation which evolved at Manchester South, and which caused an esteemed colleague to finish his career on a bitter note.

Those of us with long memories can recall instances under BR, when similarly respected Engineers were made to fall on their swords for the corporate sins of the industry. Likewise after privatisation, when commercial procurement by an organisation without a single engineer on its Board, was not tempered by common sense.

I have come to regard with dismay, the avenues along which we have been propelled in recent years. We now have a skills gap that has its origins in early retirements during late BR reorganisations plus the immediate aftermath of privatisation. That does not match well with the investment ‘bow wave’ that is now occurring.

Daily I receive emails and phone calls from Agencies that want me to return to full time employment. Looking at my recently-acquired bus pass, I am tempted rather to live on my railway pension and supplement it with part time work. Training Delivery would be one way to impart my knowledge to the upcoming generations of designers, and there must surely be a nationwide pool of willing semi or fully retired talent, which can be tapped. But not all of us can up sticks to Derby or like places, to work for mainstream training providers. Does anyone out there have any bright ideas?

Paul Hepworth

Comment on IRSE NEWS

You asked for comments - here is my initial thought as I opened the latest issue: Where is this month's London technical paper?

I was originally intending to attend Roger's presentation on Wednesday as abuse of SILs is an ever present concern in my mind. However, I'm now unable to attend and I was looking forward to reading Roger's paper in the NEWS.

If a conscious decision has been taken to exclude the papers from the NEWS, is it possible to make them available by another means?

Stephen Bull CEng MBCS MIET AMIRSE
PPP Assurance Team Leader, Westinghouse Rail Systems

Editor’s response: Thank you for your concern. Don’t worry. The New Look did not deliberately exclude the January Paper and whenever possible we will continue to feature the London Paper in the relevant monthly issue of the NEWS. Unfortunately, there was a delay in receiving this particular Paper and I was not prepared to delay the production of the January issue.

There are tight timescales needed to produce eleven copies of the NEWS per year and the team have never failed to achieve each deadline.

I am also pleased to report that both the January and February technical papers appear this month, so we are up-to-date.
Membership

Changes to Guidelines on Responsibility Levels for Membership

The Membership Committee have recently revised the guidelines which they use when assessing the level of responsibility being exercised by applicants who are either trying to join the Institution or transfer from one grade of membership to another. For the Associate Member, Member and Fellow grades, it is necessary to demonstrate experience where the applicant has exercised responsibility at varying levels. With the changes to railways and companies around the world, with less hierarchical organisational structures in many cases, the guidelines needed updating to reflect the reality of these changes.

For each of these grades of membership, the appropriate responsibility levels which are specified in the Bye-Laws, are spelt out in more detail in these revised guidelines, and the new guidelines are both shown below, and are available on the Institution’s website www.irse.org, under membership.

Responsible Experience
A Responsible position is one entailing the exercise of professional engineering judgement in the field of railway signalling or telecommunications. This may include any of the following areas of work:
- Research, feasibility studies and options evaluation;
- System, hardware or software development and manufacture;
- Applications engineering and/or data preparation;
- Verification, validation, testing or conformance assessment;
- Installation and commissioning;
- Maintenance and servicing;
- Definition and interpretation of standards, rules and regulations.

A person in a “responsible” position is typically making decisions about an individual deliverable, such as a document, a design or a test.

Senior Responsibility
A person in a position of “Senior Responsibility” takes more significant engineering decisions affecting technical and organisational output. He/she will typically be making decisions at the level of a project or an area of activity. He/she will variously engage in technical and commercial management and possess effective inter-personal skills for dealing with customers, suppliers and colleagues.

Usually, such a person will have fulfilled a Responsible position in the railway signalling or railway telecommunications engineering field (or possibly in another engineering discipline), and will now be giving guidance to those in Responsible positions.

Superior Responsibility
A position of “Superior Responsibility” is one held by someone who dictates business and/or technical policy and who has previously been in both “Responsible” and “Senior Responsible” positions in the railway signalling or railway telecommunications engineering field (or possibly in another engineering discipline). Such a person will usually be widely recognised as “eminent” within the profession. He/she may be either:
- A senior manager in a railway signalling or telecommunications business or
- Recognised as an industry-wide expert in a particular field of railway signalling or telecommunications engineering.

A person with “Superior Responsibility” is expected to exhibit leadership, vision and strategy within the profession by advancing the science of railway signalling and telecommunications, promoting the professional development of individuals and furthering the objectives of the Institution.

Current Responsibility
Where an applicant is currently not working, or working in a less responsible position than that required for the class of membership applied for, the Institution may take into consideration previous positions held by the applicant in the last two years where more responsibility was exercised.

In addition, a number of membership applicants have applied for membership shortly after temporarily either transferring into more junior roles, often in a different country, or taking a career break, and this has made it difficult to meet the Bye-Law requirement for responsibility being exercised currently. Some guidance on the interpretation of currently has also been prepared and is included in these revised guidelines.

The Membership Committee hopes that these changes will help aspiring applicants to explain more clearly their current job roles and responsibility levels since they should now know what the Committee will be looking for.

Claire Porter, Chairman, Membership Committee

There is some good news for 2009!
Council have decided to leave the 2009 subscription rates at the previous 2008 levels, so there will be no increase for everybody to find for this year. The same applies to Licensing fees - there will be no increase this year.

(Subscription rates are due on 1 July each year)

IRSE Annual Subscription
The 2009 subscriptions rates are:

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<th>Companion, Fellow</th>
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For details of Concessions and Student Discounts see the IRSE website
CROSSRAIL

Crossrail is an ambitious programme to deliver a new railway for London.
Our vision is to create a world-class affordable railway, delivered through effective partnerships and project excellence, with high performing teams sharing a clear vision and clear objectives. This is a once in a lifetime opportunity to make a significant contribution to public transport, and the quality of life, in London and the country as a whole.

Electro-Magnetic Compatibility Engineer
Salary dependent on skills and experience Ref: PH114
Responsible for setting the EMC standards for the whole Crossrail programme, you will develop and implement a robust EMC strategy, and review designs and other submissions to ensure their compliance with EMC law and regulations. Assisting in the resolution of complex issues, you will play a pivotal role in making sure we deliver to budget and on schedule. You will relish the challenge of working in a multi-disciplinary environment, developing strong relationships both with your engineering colleagues and a range of parties from several external organisations, including our design consultants, delivery partners and regulatory bodies.

A Chartered Engineer (or equivalent), you will have a proven industry track record and demonstrable experience in a comparable role. Confident and pragmatic, you are a results-driven problem solver with a range of knowledge relevant to railways, and a thorough understanding of applicable standards and regulations.

Integration and Interfaces Engineer
Salary dependent on skills and experience Ref: PH115
In this vital role, you will help us make sure we meet the requirements of our sponsors by ensuring the integration of systems across the entire Crossrail programme. Establishing and implementing Integration and Interface Management processes, an interface database and other crucial management tools, you will enjoy a positive impact on our operation. Your expertise will also be put to good use in the review of designs and other submissions, and by assisting in the resolution and control of complex interface issues. You will enjoy the challenge of building strong relationships with, and influencing, a range of internal and external parties – from engineering colleagues to delivery partners and regulators.

You will ideally be a Chartered Engineer (or equivalent experience) and combine substantial industry experience with a proven track record in a similar role, including the management of system integration in a complex multi-disciplinary environment. Confident, pragmatic and delivery-driven, you are a problem solver, with a demonstrable understanding of railway systems and the relevant standards and regulations.

If you are interested in delivering this world-class transport system contact our HR department for an application pack which includes a full job description of the role by emailing recruitment@crossrail.co.uk or by calling 020 3023 9191. Please quote the appropriate reference number as shown above.

The closing date for receipt of completed applications is 20th February 2009.

We value the diversity that exists in London and aspire to this being reflected in our work force.

See www.crossrail.co.uk for more information on our company.
You’re a rare breed
Know your power

EPCglobal’s Rail teams in Bristol and Sheffield are working with the industry’s largest active employers to fill a variety of specialist and senior vacancies on projects across the UK.

Signalling Design Manager / Head of Signalling Design Teams
£85,000 - £105,000 plus excellent package

We are currently looking for a Signalling Design Manager / Head of Signalling Design Teams to take up a very senior position with the UK’s leading Rail Company. You will need to have a vast experience of railway signalling design and be able to motivate and inspire those around you. This role will require extensive travel around the UK and will be demanding on the chosen candidate. It will however place you at the forefront of Railway Signalling Design. Please send your updated cv to the e-mail address below or call me to find out more.

Blair Hickman / 0117 970 7712 / blair.hickman@epcglobal.com

Signalling Project Managers/Engineers
Nationwide both Contract & Permanent

We have a variety of clients that are looking for both Signalling PMs and PEs. These positions will be located nationwide and will be available on a permanent or contract basis. The successful candidate will need to be of a strong signalling background and have worked on the mainline or underground. Salaries are negotiable dependant upon experience.

Fiona Macblain / 0117 970 7718 / fiona.macblain@epcglobal.com

Signalling Professionals
London & UK Wide - Contract & Permanent - £Negotiable

We are currently supporting several large clients in the delivery of major metro and mainline signalling projects. We would be very interested to speak with any signalling specialists seeking a new challenge. Whether your strengths are technical knowledge, management of signalling projects or the ability to effectively support a project team we can provide you with challenging roles on a number of high profile projects.

Ellen Hipkin / 0117 970 7709 / ellen.hipkin@epcglobal.com