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Topic: Accurate ways of risk evaluation to identify level crossings that are likely to be dangerous  
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Level Crossing Risk Tool for Portuguese Railways (REFER)  

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Abstract

The paper, which was co-produced by Arthur D Little and Portuguese Railways (REFER), gives an overview of the development and application of a Tool for assessing level crossing risk. REFER had made some very good progress in achieving level crossing closures and collision reduction, but recognised that to make further progress in accident reduction a risk-based approach would be required.

The paper describes the development of the Tool, and how this focused on the demonstration of “risk factors” those characteristics that could be shown to be related to accident occurrence. The development benefited from experience of risk assessments and research conducted on railways elsewhere including GB, Ireland and Austria. The work found some good evidence, based on data analysis and site visits, for such risk factors including non-linear relationship between traffic moment and risk, road layout and crossing / road angle, sight times and strike-in times and others.

The paper briefly introduces the Tool, giving an overview of the algorithms and how it is used by an assessor to carry out a risk assessment and cost-benefit analysis. The paper will conclude with an overview of REFER’s application of the Risk Tool since it was released in 2009.
Introduction

Like many railways, the railway in Portugal, managed by REFER, has a large number of level crossings (around 1200), many of which are not technically protected. Considerable effort by REFER through a programme starting in 2004 demonstrated some significant improvements in the level crossing risk profile. By 2007 good progress had been made on closures and upgrades. In this programme level crossings had been characterised and classified according to the type of protection, and the number of recorded incidents culminating in a five point rating system used to prioritise investment effort. Site visits to all crossings were carried out to record specific features and geometry, including estimating traffic moment (product of number of vehicles and number of trains per day). Notably, a good number of successful closures were achieved (210 closures from 2004 to 2007) and the number of reported collisions between trains and vehicles reduced.

However, other areas of safety improvement proved to be more challenging, and REFER were concerned that with the current approach it was not possible to meet targets for further risk reduction (a 50% reduction in accidents over the 2004 level by 2009; a 60% reduction in accidents over the 2005 level by 2015). Although the reported collision rate had reduced the outcome was less than planned, and when normalised by the number of crossings Portugal still showed amongst the highest collision rate in Europe. This highlighted that the programme had not been fully effective in targeting particularly 'high risk' crossings - which should be the aim of any safety investment programme. Indeed, many of the closures that had achieved have been 'the easy ones' and not necessarily those that are 'high-risk'.

The need for a risk-based approach

By 2007 it was evident that what was needed was a process with more emphasis on proactive i.e. 'risk-based' measures to better focus further investments in safety measures. An approach was required that provided an understanding of what really drives the risk to assist in more effectively identifying high-risk crossings, and make more progress towards the safety targets. In 2007 there were some 192 high priority crossings for which solutions were not in hand. Another concern was the lack of apparent reduction in the number of pedestrian fatalities at level crossings.

Scope and objectives

The overall objective of the work programme was to provide REFER with an improved method for identifying the highest risk crossings so that investment could be more effectively prioritised to facilitate more rapid progress against the safety targets, and on an ongoing basis beyond this. The two phases involved:

- Phase 1: review of the risk drivers at level crossings to identify those crossing / user characteristics that can be more associated with 'risk'
- Phase 2: produce a computer based Risk Tool that can be used by REFER to assess level crossing risk and prioritise investment in risk reduction. The aim was NOT to produce a highly theoretical academic model of risk, but a Tool that would be useful in assisting with ranking high risk crossings.
Phase 1 was completed over a period of seven months, concluding in May 2008. The work to develop the Risk Tool itself commenced in July 2008 and the tool was handed over to REFER for use in April 2009, after which was a period of piloting and revisions for approximately three months.

**Building the basis for a model: “Risk Drivers”**

The principle used to develop the Tool was to determine those characteristics of the level crossing, the railway, the road and users that can be associated with accidents. We call these characteristics “risk drivers”. The idea is that if we can determine such risk drivers, then these provide a robust way of building a risk tool since the presence of these factors at a crossing will be used to model a higher level of risk.

**Are accidents random?**

The starting point was to test the extent to which accidents occurred randomly, or not. A lack of randomness would be evidence that there must be characteristics that underpin level crossing accidents, which would be good news from the perspective of developing a risk tool; if accidents are not random then there must be characteristics that can help to model risk.

The test was to see whether there were level crossings which were having a higher number of accidents than would be expected based on a random (Poisson) distribution.

The results were clear: there were more level crossings that had experienced multiple accidents than would have been expected to occur if accidents happened randomly (see Figure 1):

- The graph compares how many crossings would be expected to have 1, 2, 3...N accidents since 1999 if the accidents occurred randomly (Poisson Distribution) with the distribution of the actual accidents
- If accidents did occur at random, then some 520 crossings would have experienced one accident. No crossings would have been expected to have more than about 5 accidents
- What has actually occurred is different, showing that accidents do not occur randomly
  - fewer than 350 crossings had had one accident compared with what would be expected randomly (>500)
  - more crossings have had 3 or 4 accidents than would have occurred randomly, and some have had 8, 9 or more which would never be expected to have occurred on a random basis
Identifying risk factors

Having shown that accidents were not occurring randomly, the next task was to identify those factors that can be most associated with accidents, to form the basis for developing the algorithms in the Risk Tool.

A combination of approaches was used to determine these risk factors:

- Analysis of all accidents from 1999-2007
- Observations of crossing characteristics and driver behaviours during site visits
- Comparison of crossings on the same routes with different accident rates
- Results of previous work developing level crossing models elsewhere

Overall, evidence was found for risk factors in six main categories: Traffic moment, Line speed, Skew, Sight times (unprotected crossings), Strike in times (protected crossings), Road layout. Each of these is explained below.

Traffic moment:

Traffic moment (the product of the number of vehicles per day and then number of trains per day) is a widely acknowledged factor determining level crossing risk. It is common sense that a higher number of vehicles and trains creates more opportunity for an accident to occur.
To test the link between traffic moment, the number of crossings with “N’ accidents was plotted against the average traffic moment (see Figure 2 and 3 below). This showed that for unprotected open vehicular crossings (Type 5 and D) there was a good link between traffic moment and accidents; those crossings with multiple accidents have higher average traffic moments.

However, for guarded and half-barrier crossings traffic moment was shown to have a much less obvious relationship with traffic moment. In fact, for half-barrier crossings the trend indicates that crossings with multiple accidents have lower traffic moments (there is no claim that this is statistically significant as this wasn’t possible with the amount of data available. Nevertheless, it provided a good indicator and was starkly different from the relationship at the open vehicular crossings).

These findings were not a surprise. Professor Stott [1] had much earlier postulated that as traffic moment increases at protected level crossings, then the queues that form actually help to prevent the potential for accidents. Therefore, as traffic moment increases from zero, accident probability increases, but it reaches a maximum and then starts to decrease as the queuing becomes extensive. This was clearly an important characteristic to model in the Risk Tool if it was not to over-predict the risk at “busy” protected crossings. (A similar approach had been integrated into the All Level Crossings Risk Model developed for GB, but the algorithms used were different to reflect the different crossing closure characteristics).

![Figure 2: Accidents versus Traffic Moment: Open (unprotected) crossings](image-url)
Figure 3: Accidents versus Traffic Moment: Open (unprotected) crossings

Line speed:

It is obvious that the faster a train is travelling at the point of collision with a vehicle or pedestrian on the crossing, the higher will be the probability of serious injury or fatality. Data analysis confirmed this relationship. The average line speed by level crossing type closely followed the historical average fatalities and weighted injuries (FWI) per collision at that crossing type (Figure 4). Analysis found no evidence that as line speed increases so does the likelihood of collision (which was not a surprise).
Figure 4: Line Speed versus Fatalities and Injuries Per Collision

Skew:

A “skewed” crossing refers to one where there is an angle between the road and the railway that deviates significantly from 90 degrees. Large angles of skew can make it difficult for road users to see approaching trains. It has long been suspected that this is a factor that can be associated with accidents but has previously been difficult to quantify.

An analysis compared the % of crossings that are “skewed” with the % of all accidents that occur at crossings that are skewed. The results show that for all crossing types accidents occur more at skewed crossings than would be expected (Figure 5). The exception is guarded crossings which can be explained by the fact that users do not make decisions to cross based on sight so skew makes less difference than it does at other crossing types. The largest impact of skew appears to be at “D” crossings – open crossings where visibility is above standard and “P” (Private crossings). Again, this makes sense because at these crossings the user must make a decision to cross based on sight of the train approach, and if there is a skew then this will be more difficult to achieve.

Figure 5: Impact of Skew on Accidents

Sight times:

At unprotected crossings (D, 5 and pedestrian X crossings) the user needs to make a decision to cross based on looking up and down the tracks. Where sight times are seriously restricted by track curvature, vegetation or other obstructions then it is obvious that traversing safely will be very difficult. Previous work\(^2\) has shown that...
there is less impact on accident rate from poor sight times than might be intuitively expected. The theory is that where sight times are short, a crossing user will have a heightened perception of risk at the crossing, and take more care when crossing. This is a well known phenomena referred to as Risk Homeostasis [3].

The analysis of sight times showed mixed results that supported the previous findings from other work. For unprotected ‘5 category’ crossings, accidents were shown to be more common where sight times are very low – which is what would usually be expected. At other crossing types, there was less evidence of the impact of sight time on accident rate. At pedestrian ‘X’ crossings for example, there was no apparent higher accident rate where sight times were below 5 seconds in comparison to where sight times were longer. The conclusion was that sight time may influence accident probability to a degree, but other risk factors are more dominant. Another possibility was that some sight times may not have previously been recorded very accurately making a robust analysis more difficult.

Strike in time:

Strike in times at automatic crossings (ASMB and ACMB) are nominally around 30 seconds, but are commonly much longer due to slower trains, or trains that stop at stations. Where strike in times are long, road users may be less reluctant to stop at the crossing, leading to higher rates of violation and more potential for accidents. From the data, no hard evidence was found linking longer strike in times with accidents. Observations provided some evidence, however, that crossing users can get very impatient where they have to wait for much longer than the nominal 30 seconds. A good example was a pedestrian crossing with lights in Lisbon which has very long strike in times (up to 120 seconds depending on train speed) in one direction. Despite the lights being very visible, pedestrians can be seen to routinely ignore the warning and use their own judgment about whether it is safe to cross. Often, pedestrians cross many 10s of seconds after the alarm and lights have been activated.

Road layout:

A characteristic of a high proportion of crossings in Portugal is the complexity of road layouts immediately adjacent to the crossing. At some locations, immediately after or before the crossing there is a ‘T’ junction with a road parallel to the railway tracks. This can mean that vehicle drivers turning onto the crossing from the parallel road are less aware of the crossing before they arrive at it (despite their often being advanced warning signs). Also, it is more likely that queues will form over the crossing. By contrast, for example, at British crossings it is unusually for there to be road junctions near to the level crossing, or other road features that could create traffic queues or road accident hazards.

It was not possible to derive significant relationships between road complexity and accident rate, although previous work in Austria had shown that accidents at crossings near to junctions were comparatively more
common. Nevertheless, it was judged that road layout complexity would have a bearing on probable accident rate.

The Risk Tool

Overview
The Risk Tool takes the form of a user interface in Excel and Visual Basic for Applications (VBA) algorithms. Data for all crossings on the rail network are stored and retrieved via XML to a central server (or locally when using the tool remotely).

<table>
<thead>
<tr>
<th>What does the Risk Tool do?</th>
<th>What does the Risk tool NOT do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides estimate of risk to crossing users, passengers and staff on trains</td>
<td>Does NOT replace the need for good engineering judgement</td>
</tr>
<tr>
<td>Uses extensive data collected previously by REFER and in new site visits</td>
<td>Does NOT automatically account for all highly specific local issues (such as behaviour of specific individuals living near crossing)</td>
</tr>
<tr>
<td>Allows cost and benefit analysis of options to reduce risk at specific crossings</td>
<td>Does NOT check that inputs to Tool match reality – care and judgment is required by the assessor</td>
</tr>
<tr>
<td>Checks inputs are logically</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Tool Outline

The Tool steps the assessor through a structured process, denoted by boxes at the top of the screen that show the progress towards completing and running the assessment (Figure 6). The steps are:

- Provide all required inputs for selected crossing type – these are then verified as OK
- Risk calculated
- Risk saved to database or locally
- Cost-benefit analysis (CBA) inputs entered and verified as OK
- CBA calculated
- CBA saved to database or locally
An important aspect of the Tool is self-checking of user inputs for ‘sense’ before running the risk engine. This includes typographical errors (such as entering letters where number are required) and checking the range of single inputs, and logical relationships between inputs.

**Tool inputs**

Before running the Tool, all inputs must be provided on the ‘Input’ sheet.

The inputs that are required depend on the crossing type; once this has been selected then the inputs that are required are marked by yellow coloured boxes. Grey shaded boxes denote inputs that are not required for the selected crossing type, or are inputs that are ‘read only’ and cannot be changed by the Tool user.

A ‘Status’ column shows the required action for the Tool user, for example specifying the required type / format of input required. Double-clicking on any input shows an information box providing a fuller description of the input required, and for which crossings it is applicable.

In the example below, many inputs have been entered and checked by the Model as being valid – so the status is shown as “OK”. The assessor has made an error entering ‘Upside traffic approach road H’ and is shown an error in the status. Inputs below that have yet to be entered, so the status indicates the type or range of input required in blue text.
Algorithms

Base events:

The backbone of the Tool is a series of “base events”, or categories of accident causes. These describe the general historic causes of accidents that occur at level crossings. For each crossing type, the % of accidents caused by each base event were estimated from reading accident investigation reports, and through a workshop with REFER Operations staff. There are 7 base events for pedestrian accidents, and 8 for vehicle accidents as shown in Table 2 and 3 below. In the column for each crossing type, the estimated fraction of accidents by each cause is shown (for example, at pedestrian ACMB crossings, 65% of accidents were determined to be causes by road vehicle users ignoring lights / zig zagging barriers).
Table 2: Pedestrian accident causes and breakdown by crossing type

<table>
<thead>
<tr>
<th>Accident cause</th>
<th>D</th>
<th>5a</th>
<th>X</th>
<th>Xa</th>
<th>ACMB</th>
<th>Guardada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stuck / fall</td>
<td>0.10</td>
<td>0.10</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Look for train but fail to see it</td>
<td>0.20</td>
<td>0.30</td>
<td>0.15</td>
<td>0.05</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Ignore lights, or zig zag barriers</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.65</td>
<td>0.70</td>
<td>0.90</td>
</tr>
<tr>
<td>User sees train but tries to nip across</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User struck by a second train</td>
<td>0.00</td>
<td>0.00</td>
<td>0.20</td>
<td>0.25</td>
<td>0.20</td>
<td>0.00</td>
</tr>
<tr>
<td>User fails to look for train</td>
<td>0.55</td>
<td>0.45</td>
<td>0.45</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Railway / crossing failure</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table 3: Vehicle accident causes and breakdown by crossing type

<table>
<thead>
<tr>
<th>Accident cause</th>
<th>D</th>
<th>5a</th>
<th>X</th>
<th>Xa</th>
<th>ACMB</th>
<th>Guardada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stuck / grounded</td>
<td>0.10</td>
<td>0.10</td>
<td>N/A</td>
<td>N/A</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Look for train but fail to see it</td>
<td>0.15</td>
<td>0.40</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Ignore lights, or zig zag barriers</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.65</td>
<td>N/A</td>
</tr>
<tr>
<td>User sees train but tries to nip across</td>
<td>0.10</td>
<td>0.10</td>
<td>N/A</td>
<td>N/A</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User struck by a second train</td>
<td>0.00</td>
<td>0.00</td>
<td>N/A</td>
<td>N/A</td>
<td>0.00</td>
<td>N/A</td>
</tr>
<tr>
<td>Railway / crossing failure</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.05</td>
<td>0.70</td>
</tr>
<tr>
<td>User fails to look for train</td>
<td>0.60</td>
<td>0.35</td>
<td>N/A</td>
<td>N/A</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Blocking back</td>
<td>0.05</td>
<td>0.05</td>
<td>N/A</td>
<td>N/A</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Accident frequency:

The second step of the risk algorithms is to estimate the frequency (number of times per year) that accidents could occur. Historic data provides the average frequencies (events per year) of accidents at each crossing type. To determine the predicted frequency of accidents at an individual level crossing the algorithms adjust these frequencies for each causes according to the characteristics of the crossing defined in a wide range of user inputs. Three main types of adjustment are made:

- Firstly, the level of traffic, based on a census carried out at the crossing, is considered. For all crossing types, the frequency of train / user collisions will depend on the number of users and the number of train movements. The algorithms consider that the relationship between traffic moment and the chance of an accident is not linear for all crossing types and starts to decline at high levels of traffic (as discussed in “Risk Factors” section of this paper, above). The nature of the relationship between the traffic moment and the accident rate varies depending on the cause of the accident and the crossing type. For some accident causes at busier crossings, the accident rate is modeled to be non-linear to the traffic moment, because as the road traffic increases there is a reduced opportunity for interaction between a vehicle driver and the train. In effect, the road traffic ‘chokes’ meaning that any given vehicle is less likely to be the first vehicle to encounter the level crossing when it is activated. Vehicles follow one another and drivers control their vehicles to stop behind the vehicle ahead, rather than responding directly to the crossing equipment.

- Secondly, the crossing, railway, road, and user characteristics (e.g. speed of approach, user behaviour, road layout, visibility etc) are considered. The Tool adjusts the likelihood of base event (accident cause) (described in the section above) to take into the inputs describing the crossing, user, road and railway characteristics. These algorithms were developed on the basis of the work on the risk factors described earlier in the paper. For example, a pedestrian crossing which has lights (Xa) would be predicted to have a higher frequency of accidents due to people ignoring lights, if it had long strike-in times (because people would be more likely to ignore the lights due to impatience). For each crossing type the algorithms describe how the base event is adjusted according to complex combinations of input data. Figure 8 below illustrates graphically the influences between inputs (orange boxes) and base events (blue boxes). In general, the adjustment of the base events is set so that the range is an order of magnitude (i.e. the average frequency of accidents for each base event can be increased by a factor of 3 and decreased by a factor 3 – or left unchanged at 1 for an “average crossing”). The principle here is therefore that crossings with ‘typical’ features will retain the average frequency, whilst causes for some crossings will either be increased or decreased from this average value, depending on their specific characteristics.
Thirdly, the proportion of heavy traffic using the crossing has an impact on the frequency of accidents. Heavy vehicles such as trucks and farm vehicles are more likely to be involved in level crossing accidents than other road vehicles – this has been shown from analyses\textsuperscript{[4]} before in other countries and was shown again in Portugal. The Tool adjusts the probability of an accident at a particular level crossing to account for the proportion of heavy vehicles using the crossing.

Figure 8: Type 5 and D crossings: relationship between inputs (orange) and base events (blue)

**Accident consequences:**
The Tool considers the three groups exposed to level crossing accident risk – passengers, train staff and the public using the crossing. The Tool takes into account the probability of train derailment at the crossing, which depends on the type of road vehicles using the crossing (heavy vehicles are more likely to cause derailments).

Calculating risk:

The Tool determines safety risk in two ways

- Collective risk (measured in Fatalities and Weighted Injuries (FWI) per year)
- Individual risk (measure in annual probability of fatality to regular users)

Collective risk is determined by combining the results of the frequency and consequence analyses:

\[
\text{Collective risk (FWI/yr)} = \frac{\text{Collision frequency / yr} \times \text{FWI / collision}}{}
\]

Individual risk of fatality is the probability per year of fatality to a regular user of the crossing (assumed to be 250 return trips per year – that is 500 traverses of the line) and is independent of the number of crossing users.

Individual risk of fatality is a normalised measure of risk – i.e. it is essentially independent of the number of people using the crossing, providing a measure of the level of risk to a typical exposed user, regardless of the number of users. This is useful as it provides an indication of the level of risk due to the properties of the crossing and the railway – i.e. not due to the number of users - such that crossings can be compared to one another and to ‘benchmark’ levels of individual risk.

Tool Outputs

Once the inputs are checked OK, and the algorithms are successfully run, the Tool displays the outputs to the assessor (see Figure 9). In overview these are:

- Collective risk
- Individual risk
- Collision frequency

These are broken down by vehicle type, and the proportion of collisions that lead to derailments.

\[1 \text{ FWI} = 1 \text{ fatality OR 10 major injuries OR 200 minor injuries}\]
Risk mitigation

A key feature of the Tool is the capability to specify the impact of risk control measures that have been installed at a crossing, or to override base case calculations relating to individual accident causes. This may be done for two main reasons:

- Part of base case crossing assessment: Where the base case crossing being assessed has had a mitigation measure already implemented, or where for some reason the assessor has good reason to believe that the Tool is not assessing the cause of accidents correctly. In this case, a % reduction (or increase) in each individual accident cause may be specified as part of the base case assessment.

- As part of cost-benefit analysis: When assessing possible options for risk mitigation, as part of cost-benefit analysis. Again, the % reduction in each individual accident cause may be specified, and cost-benefit parameters (such as cost, project life etc) be set to evaluate the costs and benefits of an option.

In both cases, the relative magnitude of each cause of accident is shown on the input screen before the algorithms are run. The value of the accident cause is shown as “below average”, “average” or “higher than..."
average” in the ‘Status’ column adjacent to each accident cause (see below). A result that is derived as “average” means that the features at the crossing do not make the risk any higher or lower than most other crossings of that type. A “higher than average” factor increases the impact of the particular accident cause at the crossing, which increases the overall risk assessed by the model. A “lower than average” factor has the opposite effect.

**Cost benefit analysis**

A cost-benefit analysis recalculates the risk at the crossing, based on the assessor specifying changes to values of specific inputs, and compares this to the costs of the project as defined by the assessor. This cost-benefit algorithms take a standard economic investment approach – discounting costs and safety benefits (using Value To Prevent Fatality) over the relevant period of time. The results provided to the assessor are the new risks following the specified changes, and special ‘cost-benefit’ outputs indicating the discounted risk saved, and the discounted costs.

This feature of the Tool is an important aspect of its use in helping to guide management decisions about investment. For a particular line of route, for example, managers can see where safety investment in level crossing closures or upgrades make sense from a financial point of view.

**Challenges and lessons learned**

The development of the Risk Tool had to overcome some interesting challenges:

1. REFER had excellent information about their level crossings from previously completed surveys but this did not provide all inputs required by the Tool.

2. Although the team had experience of developing several other risk models and tools elsewhere, there were characteristics of crossings in Portugal that were different. Site visits, user observations and a good understanding of how crossings operate is essential if the factors affecting risk are to be understood.

3. REFER required a Tool that could be used immediately without the need for extensive re-calibration. One of the characteristics of the type of Tool produced is that it requires “average” values for inputs and combinations of inputs, which are then adjusted up and down by the algorithms to produce the risk assessments of specific crossings. For example, the base event “user looks for train but fails to see it” at open crossings, is a function of several inputs - sighting distance, skew, traverse time, whether low sun is a problem. The problem is, that before collecting all input data for all crossings, it is not known how these characteristics are distributed - for example – what the “average” sight times and traverse times
An extensive analysis was completed which involved compiling all known input data into spreadsheets, and modeling how these combined over the whole population of crossings. This indicated how the inputs should be combined in the algorithms so that the resultant risk assessments for all crossings would distribute them sensibly from “low risk” to “high risk”. This was a time intensive and iterative process as it involved modifying the algorithms, and seeing how this impacted on the risk distribution, and repeating until the distribution was sensible.

Results, value-added and looking ahead

Implementing the Risk Tool

A programme of level crossing site visits to collect key data for the Risk Tool was carried out with internal resources from REFER. This decision was reached to secure consistency of application, and because of the need to access certain data that is held by REFER. The other benefit is that knowledge and expertise in managing level crossing risk remains “in house”.

To date 70% of the 1191 crossings have had a survey completed, collecting all the necessary data to populate the Risk Tool. A significant quantity of information is collected to populate the Risk Tool and to maintain records; approximately 100 items of data are needed for each crossing including photographs, a traffic census and characteristics of both the road and rail infrastructure.

Progress on running the Risk Tool has been somewhat slower than originally planned, with approximately 20% completed to date. The rate of progress is now around 5 assessments per computer per day. It is planned that all risk assessments will have been completed in early 2011.

Each team assigned to the programme consists of 2 to 4 persons drawn from both the level crossing department and the maintenance crew. This way it was possible to blend a more academic knowledge with the engineering and site specific know-how from the local teams. This team approach to assessments has proven to be useful in sharing knowledge and making best use of in-house expertise, combining existing knowledge with a new focus on risk.

Using the Level Crossing Risk Tool to assess the risk, and in particularly the cost benefit analysis approach, has proved to be a steep learning curve. However, value is already being demonstrated in these relatively early stages of implementation, through significantly strengthening the decision making process regarding upgrades and closures.
Collision reduction targets

The good news is that the 2009 target of a 50% reduction in collisions over the 2004 has been achieved. 2009 saw 49 collisions against a target of 52 or lower.

Looking ahead

A new target has been set for 2015 – 29 collisions (which represents a 60% reduction over 2006). This is considered to be ambitious, particularly in the current economic recession which has led to constraints on the budgets for safety related investment on level crossings. The Risk Tool will be perhaps even more necessary as a result, since the capability to carry out a robust cost benefit analysis and risk assessments based on tangible risk drivers will enable prioritisation of the limited funds available.

As the assessments and cost benefit analyses are completed for each line, and finally all 1191 crossings, the ability to make robust investment decisions for risk reduction increases. This is because the limited funds that are available can be optimised to tackle those lines, groups, or individual crossings where greatest overall risk reduction can be achieved.

References