IMPROVING OPERATIONAL AND PUBLIC SAFETY IN SHUNTING OPERATIONS THROUGH ACTIVE HAZARD ID

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SUMMARY

Shunting[1] collisions have been widely accepted as an inevitable consequence of operating the railway over the past one hundred and fifty years. They have been a common occurrence that have crossed the spectrum of consequence from low risk, minimal cost incidents to fatal accidents resulting in significant damage to equipment, railway infrastructure, line side customers' premises, road vehicles, pedestrians, customers employees and rail personnel.

While the facts can speak for themselves we don't have to continue to accept the inevitable. As safety professionals we can take action and implement change that will reduce the likelihood and consequence of shunting collisions. After assessing historical shunting collision data and the attempted improvement initiatives undertaken it was identified that a substantial improvement in shunting safety would not be achieved unless a new approach was adopted by rail personnel who undertook the shunting task.

This paper provides a summary of historical organisational factors, an explanation of the strategy adopted, why this approach was adopted and the resulting improvement achieved.

INTRODUCTION

KiwiRail's approach to operational training is based on a prescribed system of formative classroom learning, on the job training under supervision, safety observations and classroom based biennial theory recertification assessment.

The forerunner of this training and competency system was developed and introduced in 1978 by the Traffic Branch of the Railways Department following a fatal head to head collision on 23 March 1977 between a northbound locomotive hauled express freight train and a locomotive hauled passenger train running on the wrong line in the vicinity of Newmarket[2]. In 1977 values the accident costs were estimated to have exceeded NZ $500,000.00 (1), an equivalent economic cost of NZ $3.6 million today.

Following the accident, a Board of Inquiry was established and a report presented to the New Zealand House of Representatives. The report identified a number of deficiencies that required corrective action. These included initial training and annual assessment of competence for operating staff (2).

As a result of the enquiry, the Railways Department, established an independent Traffic Training Unit.

Shortly thereafter it was recognised by executive management and the Minister of Railways that the railway would need to change in both form and substance if it was to survive as a viable entity in the modern era. In early 1979 the General Manager of the Railway's Department signalled a major repositioning and restructuring of the railway in a booklet titled *Time for Change*, this set in motion as series of significant transformations affecting management, staff and the organisation objectives to be achieved.

[1] Shunting: moving rail vehicles within a terminal, yard or siding, or when working a siding from the mainline (known as switching in North America).

[2] Newmarket is located 3 kilometres south of Auckland on the North Island Main Trunk Line. At this junction westbound trains continue on the North Auckland Line and northbound trains join the Newmarket to Auckland Line. Immediately on leaving Newmarket the line to Auckland runs into a short cutting before entering the double track Parnell tunnel. Exiting the tunnel is a short but steep grade that is the approach to Auckland Station.

Figure 1. Newmarket Accident, 23 March 1977

Figure 2. Final position of Locomotives

In the mid-1980s as part of restructuring, the Traffic Training Unit was abolished and the responsibility for training, initial certification and biennial recertification placed back into the Operations Business Group (the successor of the Traffic Branch).

Throughout the 1990s restructuring continued unabated and was a common feature of the railway including its sale to private ownership. At about this time two significant changes were made to the initial certification and ongoing competency assessment processes.

Tranz Rail (a predecessor organisation of KiwiRail) then made two noteworthy variations.

The first occurred during a restructuring of the Operations Business Group. This abolished the regional training supervisors' positions and passed the responsibility for recertification onto the line managers who controlled terminal and train operations. This change diluted the competency oversight controls established post the Newmarket accident, rendering them ineffective.

The second major change occurred shortly after the first and was a positive attempt to improve safety outcomes through the introduction of a safety observation system based on a North American railroad's efficient testing program.

Safety observations of operating personnel were initially conducted on a twelve monthly cycle personnel and were intended to provide two key deliverables:

- direct feedback to rail personnel on their safe working compliance with standards, rules, codes and local instructions, and
- assurance to line management that rail personnel were competent to perform the work for which they were engaged.

Circa 2000, the frequency of safety observations was increased to provide for seasonal and environmental variation. Prior to this change, individual rail personnel were being assessed for current competence and safe working knowledge at about the same time each year. This approach resulted in the annual observation on an employee being conducted in similar environmental conditions and operating tempo as the previous assessment, a situation that was not desirable.

Were these two changes successful or did they contribute to a decline in safe working performance?

For some managers the changes were positive. This group of line managers fully understood their operations, had retained operational qualifications and, held current safe working competency. They fully embraced the changes which provided full control over the processes, making them accountable for ensuring that safe working knowledge was retained and understood by their staff.

Others managers, also holding operating qualifications, saw it as an additional burden that had been placed upon them and a distraction from their primary role of managing an operations terminal or line haul operation.

A third group struggled, they never fully came to terms with the responsibility or they failed to realise that recertification and theory assessment was a very important task, one that they should have been paying a lot of attention to. Although they may have tried to make a go of it, the results were generally poor and delivered in many cases in an environment where the line manager supervising the assessment was unable to provide direct and constructive feedback to the employee completing it.

Change in the new millennium

While the safety observation and theory assessment processes had continued to meet regulatory expectations, they delivered mediocre results. By mid-2005 anecdotal evidence suggested that a review of current practices was necessary.

The value of sensing, data analysis and knowledge retention

Reviewing recent history, it was now apparent to experienced rail personnel that all was not well. Deficiencies and contributing factors that had been identified and eliminated by earlier corrective actions were reappearing. Cognisant with what had occurred at Newmarket in 1977 and the failings of the training system that had been in place at that time alarms bells began to ring. Executive Management where briefed and advised that the operational competency management system had been restructured, degraded and diluted to a point that it now closely reflected what had been in place at the time of the Newmarket accident.

Armed with the knowledge that there was potential for a critical system failure the General Manager Operations put a proposed restructuring of operations management on hold and sponsored an internal review. A Special Technical Committee was established for this purpose.

Commencing its work in mid-2005, the Committee quickly identified that with some minor exceptions a lack of safe working theory knowledge had not been a significant contributing factor to railway accidents and incidents over the past five years, it was how retained knowledge had been applied that was the problem.

The Committee's work also identified that there were sufficient warning signs presenting, to indicate that the company processes for retained theory knowledge assessment, final sign off of employee competency to perform rail safety work and safety observations were:

- inconsistently applied across the business;
- becoming increasingly ineffective; and
- an urgent need of an overhaul before something went badly wrong.

The Committee went on to review the training, competency assessment and safety observations processes from end to end over the complete lifecycle. Key recommendations were subsequently adopted, including:

- establishment of a new Operational Competency Manager position in each regional management team (modern day Training Supervisors with a broader scope than those that had been disestablished in mid-1990s);
- reinstatement of a classroom recertification day where all operations staff would come off the line and into a classroom for biennially theory assessment and case study group discussions (known as revalidation workshops[3]);
- a reduction in the number of safety observation assessors; and
- a moderation process to ensure that assessors were working to best practice guidelines.

Exposing the weaknesses in the current competency management system had provided an opportunity to correct the deficiencies in current practices and identify options to address safe working competency deficiencies.

Introduced in 2006, the revalidation workshop is conducted in a single day away from line duties. It has been successfully delivered by the Regional Occupational Competency Managers to rail personnel holding safe working qualifications in the Freight Business Unit. The program runs over a twenty four month cycle with safety performance statistics updated as it progress to ensure the currency of information. Locomotive engineers, yard staff, supervisors and managers attend the same group workshop sessions to embrace teamwork and further advance the principles of crew resource management (CRM).

Although generally understood by locomotive engineers, who had been formally trained, CRM concepts and behaviours had not been introduced to ground staff. This lapse created a gap that resulted in a number of CRM opportunities being lost and avoidable accidents occurring.

[3] The scope of the revalidation workshop was designed to reach far beyond previous "recertification days". It is the vehicle to deliver case study sessions, disseminate learning's from recent occurrences, reinforce changes to safe working practices that had been introduced in the past 24 months (as second opportunity to provide assurance that the change had been understood and retained) and highlight national safety performance, with additional aims of engaging staff, dispelling myths in respect to accident causations as well as including the traditional intent of recertifying rail personnel in safe working theory knowledge.

Since 2006 CRM has been a core component of the revalidation workshops using case studies, group exercises and discussion. This approach has added significant value to the revalidation day for all who attend and reinforced how positive CRM had been used effectively to prevent accidents and where its absence had resulted in an accident or serious incident.

Could the outcomes from safety observation be improved?

While introduction of the Occupational Competency Manager positions embedded in Regional Management Teams had a positive impact and had been the enabler for the reintroduction of a biennial revalidation program further change was necessary as operational safety performance had plateaued.

Two organisational factors were identified:

- acceptance from management and supervisors of safety observations as a valuable mentoring tool was still far from desirable; and
- there was no weighting or consideration of risk formally applied to the safety observation process.

It (the safety observation process) contained a list of key tasks to be observed for each activity. These included; shunting, train inspection and driving locomotives. An Assessor was required to review the previous assessment and identify any key task's that had been flagged as requiring improvement and then scheduled for inclusion in the current assessment along with a selection of other tasks. This process was far from adequate and often resulted in sub-optimal assessments that were seen as being an administrative task or a burden rather than a defence against ineffective application of safe working practices.

Anecdotal evidence also suggested that some assessors where consistently selecting the easier to assess tasks resulting in some critical safe work procedures not being assessed. Although this practice still met the requirements, it circumvented the intent of safety observations, reducing the effectiveness of a control implemented to lower the risk of another incident, like that of Newmarket, occurring again. With the key focus point identified the main effort now shifted to improving the quality of safety observations.

Compulsory tasks were mandated for assessment at every observation which linked to a control for the mitigation of fatal and serious harm and injury risk. These tasks were derived from a separate but parallel piece of work to review operational risk.

With high risk tasks now being assessed more frequently, management assurance was improved. Although monitoring of this change saw some improvement this was insufficient to achieve the step change in safety performance that was required.

The frequency of shunting collisions continued to increasing by 20% in the fy2008 - fy2009 period. Although fy2010 achieved a static result the indications were that without intervention the number of collisions would continue to climb as traffic volumes grew in coming years (see Figure 1).

Although many of these collisions were minor in nature it was important to recognise that every event introduced an unwanted opportunity for the rail personnel involved in the work or our customers personnel to be seriously injured or killed. With the trend heading in the wrong direction further analysis was required to identify the contributing factors and develop a safety improvement strategy that would arrest this adverse trend.

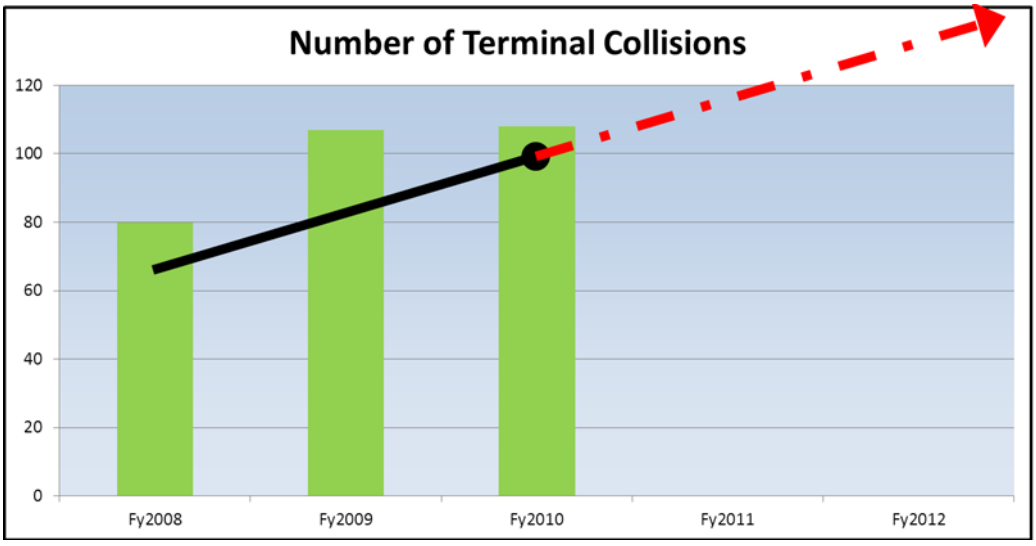

Figure 1. Bar graph showing the total number of terminal collisions increasing each financial year (Fy).

What did occurrence investigations identify as the key contributing factors?

Every shunting collision occurrence is the subject of a formal investigation with the primary objective being;

- the identification of the contributing factors;
- establishment of causation; and
- implementation of corrective actions to prevent recurrence.

These critical components are the enablers for the development of business performance improvement strategies to reduce risk, improve safety and eliminate avoidable cost.

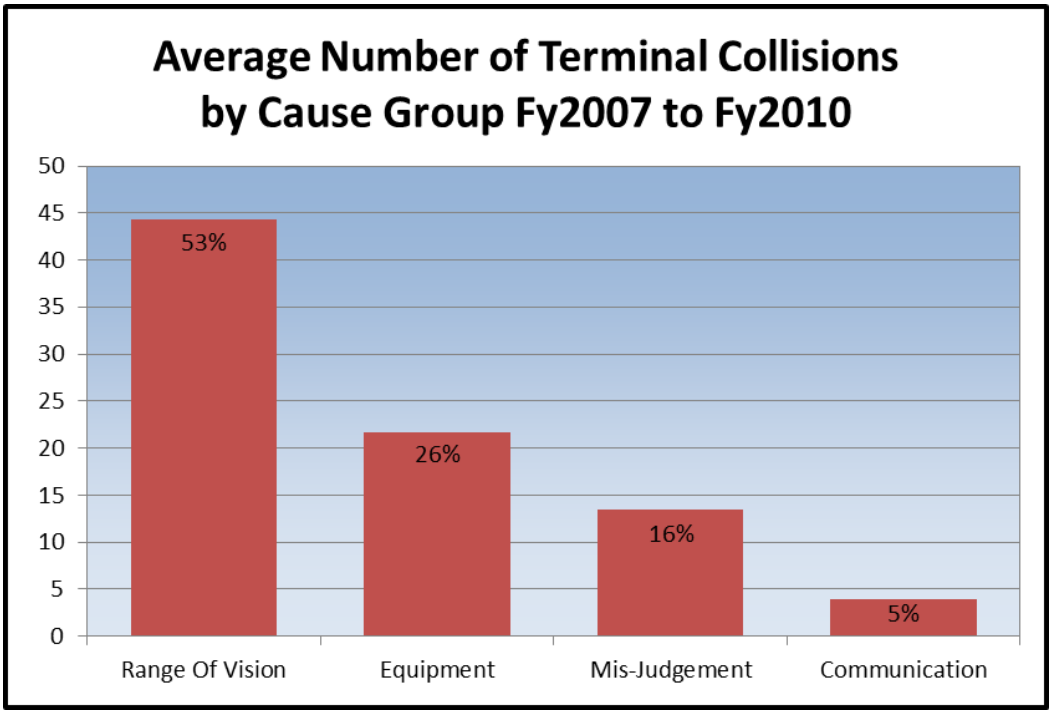

Figure 2. Bar graph showing the average number of terminal collision by cause per year and relative percentages.

Four primary contributing factors were identified, these were:

- range of vision;
- equipment;
- misjudgement; and
- communication.

To be effective any program that was introduced would need to be orientated so that it delivered improvement in these four domains.

Was safe working knowledge assimilated and retained by rail personnel?

From the investigation analysis completed to support the Special technical Committee it was clear that retention of safe working knowledge was not a primary contributing factor. Rail personnel in most cases could recall the requirements of the safe working procedures for the work that they were required to undertake and explain how these were to be applied.

Were Rail Personnel demonstrating the critical safe working behaviours?

A separate review of safety observation key tasks identified that when formally observed for application of safe working procedures, it was rare for rail personnel to make an error. This supported the findings of the biennial theory assessments and investigation reports that safe working procedural knowledge had been successfully assimilated and could be applied correctly to operational safety work.

If competency was retained and safe working procedures understood why were shunting collisions occurring?

While the biennial theory assessment and safety observation programs confirmed that in most cases rail personnel retained the knowledge of how to work safety and that they understood the core safe working procedures, the operating statistics clearly indicated that retention of core safe working knowledge on its own was not delivering any significant improvement toward reducing the likelihood and consequence of shunting collisions.

Further analysis indicated that many of the occurrences resulted from hazards within the environment that may be present one day and not the next. Environmental factors included weather, steam or exhaust from plant and factories and boilers, road traffic at passively protected level crossings, premises and port company gates, pedestrians, fork hoists, trucks and other distractions in customer sidings.

In many cases a collision had resulted when one or more of these hazards had not been considered and defensive action taken prior to, or immediately upon, encountering it. This analysis provided the tangible evidence and link to safety performance that confirmed while rail personnel were competent to undertake shunting activities they did not consistently engage fully or consider the prevailing environmental conditions. These conditions were wide and varied with every site having a unique set of hazards to be considered on every occasion that shunting was to occur.

Clearly a new approach was required if any sustained and long-term improvement was to be achieved.

DEVELOPING A SITUATIONAL AND PROCEDURE BASED TOOLBOX TO ENABLE CHANGE

Could shunting safety be improved by changing the way in which rail personnel engaged with the environment where the work was performed?

Executive Management support was sought and gained to take a very different approach to how rail personnel were trained. While this approach would set the route toward a new direction it had the potential to deliver results by doing something different, something that deviated from our traditional railway thinking of rules based training, something that considered the environmental interface, dynamic hazards and risk that may be present at any given point in time. Although this development work was initially intended for delivery in the biennial revalidation program it has now also been included in initial formative training as a teaching tool.

The keys to this change would be four tenants:

- a reduction of terminal collisions caused by range of vision errors;
- the introduction of a new notion, that hazards could be dynamic (present one day but not the next);
- the method must engage Rail Personnel in interactive shared learning sessions; and
- the system would not be based on our traditional text book style learning (chalk and talk).

After deciding on an experiential learning approach the animation toolbox was developed with support from a company who had completed animation projects for defence and police.

Scenarios were built and the storyboards constructed to address the two high frequency contributing factors that had been identified. These were:

- if the person controlling the shunting movement had been standing in a correct position where they could see other people or vehicles (range of vision) and travelled at a safe speed, then the collision could have been avoided; and
- the method of working employed by rail personnel (compliance mode) failed to take account of all hazards on any given day and the impact of wider environmental conditions.

While the positioning of personnel on the ground could be addressed with relative ease, moving the thinking of personnel from a do as you have been trained mode into a plan, check, then act mode would be new to many ground staff.

Could the thinking of rail personnel be reoriented from traditional rules based compliance into self-management of workplace hazards through active and on-going identification, isolation and control?

To test this notion animation was developed that replicated a series of shunting accidents. Initially this was only intended to improve performance against the two primary accident causes:

1. Incorrect application of the range of vision safe working procedure, a critical control in minimising the likelihood of rail vehicle collisions, derailments and other incidents; and
2. A lack of hazards awareness and defensive shunting behaviours. Investigations had identified that rail personnel often had not considered the environmental conditions on the day of the accident resulting in a lack of hazard control.

What does the data now tell us?

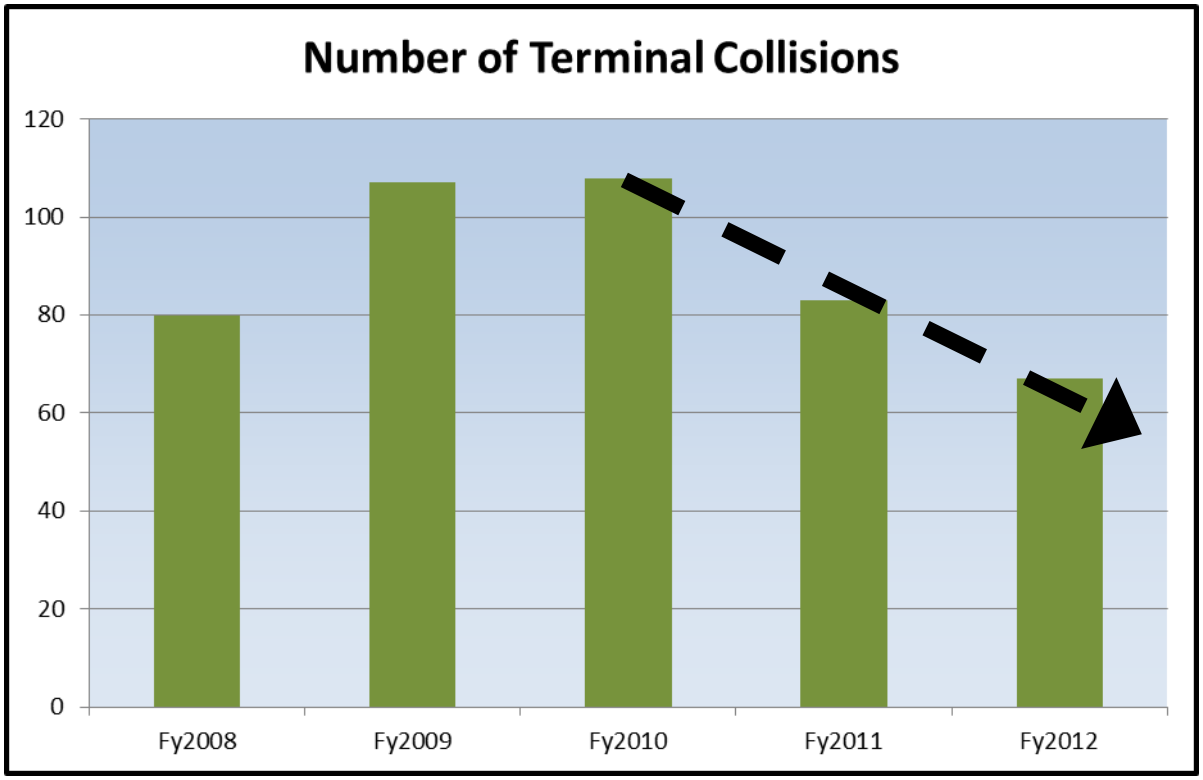

Figure 3. Bar graph showing the total number of terminal collisions each financial year (Fy).

CONCLUSION

Having recognised that a new approach was required to deliver a step change in shunting safety KiwiRail analysed collision statistics over a five year period and embarked on a journey to develop a new method that would orientate rail personnel into a work method that dynamically considered the prevailing environmental factors likely to impact on shunting safety.

Safe working animations for shunting operations were developed to demonstrate through experiential learning what the likely outcome might be if the safe working procedures were not applied correctly.

This approach has been positively received by both attendees and facilitators. Key to this has been the deliberate strategy that required animation to:

- providing something new, it must not have been seen or used before at work;
- moving away from traditional chalk-&-talk presentation of information to experiential learning;
- identify hazards that ground staff can directly influence and control to improve safety outcomes; and
- provide both visual and interactive opportunities for learning and sharing of individual's experiences.

While the direct feedback from rail personnel and trainers has been positive and the results achieved are very positive. The approach taken has significantly exceeded expectations developed in the concept stage with an immediate reduction in shunting collisions of 23% in fy2011 compared to fy2010 and as at the end of fy2012 a total reduction of 38% comparing fy2010.

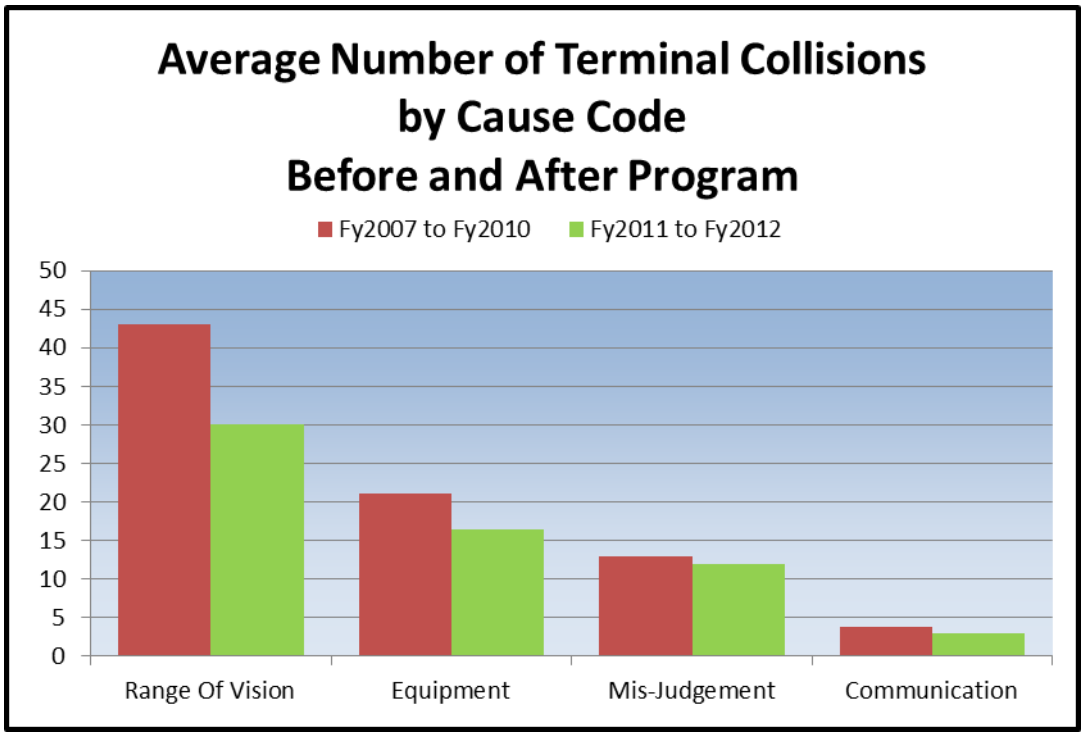

Figure 4. Bar graph showing the average number of terminal collision by cause per year, before and after the introduction of the new animated revalidation tool.

Through the Association of American Railroads KiwiRail has shared the animation approach with the major U.S. rail carriers who are reviewing it for future training programs.

The experiential learning approach has taken KiwiRail on a new journey, one that has in reality just begun and has significant potential for further exploitation and development across a wide scope of operations and activities.

References

1. **Churchman, G B.** *Danger Ahead.* Wellington : IPL Books, 1992. ISBN 0-908876-74-2.

2. **New Zealand Government.** *Board of Inquiry Into the Collision Between Two Trains Near Newmarket.* Wellington : E.C Keating, Government Printer, 1977.