

**DEVELOPING AND MAINTAINING STAFF COMPETENCE
COMPARISONS WITH RAIL INDUSTRY EXPERIENCES**

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Abstract

Competence plays a very important role in controlling risks – not just safety-related but also those which have significant impact on the operation of assets and services.

Over many years the rail industry has developed formal systems for developing and maintaining the competence of key operational staff. In 2007 it became a legal requirement for railway operators to have formal systems in place for developing and managing the competence of staff engaged in activities such as vehicle operation, asset maintenance, safety-related communication and protection of workers. Additionally, anyone engaged in delivering practical training in any of these activities must now also be occupationally competent and have their competence managed within a formal system. Waterways, like railways still rely heavily on the competence of operational staff to control risks (and to take appropriate action when things do go wrong). Despite the relative maturity of rail industry competence management systems there are still very few organisations that have successfully made the link between task analysis, risk assessment, training (including appropriate use of simulation) and ongoing assessment.

This paper draws on experiences in the UK rail industry and explores some of the issues that its organisations have faced and assesses their relevance to managing safety on canals and waterways, including:

- The need for a management system for developing and maintaining operator competence
- The core principles of an effective competence management system
- The role of risk assessment in design of competence management systems
- National Vocational Qualifications (NVQs) and their place in assuring competence
- Aiming for a continuous assessment process

1. INTRODUCTION

Railway operations are still largely a human activity where the competence of individuals is often a significant risk control measure. Given this feature of its operations, and several major accidents where human performance was a significant contributory factor, the industry has required its various constituent organisations to have formal processes in place for developing monitoring and maintaining the competence of staff carrying out safety critical work. These arrangements have been in place for nearly a decade and so are now well-established. Operations on waterways (and indeed other industry sectors) have many similarities with railway safety critical activities. This paper seeks to explore some the fundamental concepts of competence management, how they have been applied in the rail industry and their potential relevance to waterways organisations.

1.1 What is 'competence'?

There are many definitions of what 'competence' is and this probably reflects that it's a complex concept; you know it when you see it (or more often when you don't see it), but it's difficult to describe. Most definitions include references to 'ability', 'skills' and 'knowledge'. Certainly, competence is more than any one of these components on its own. There is also a tacit acceptance that competence develops over time, indicating that experience is an important factor. These attributes all relate to an individual's ability; whether they are able to do the task. However, an important consideration should surely also be whether the individual chooses to apply these attributes; their willingness to perform. A simple model of the components of competence could therefore be expressed as shown in Fig.1:

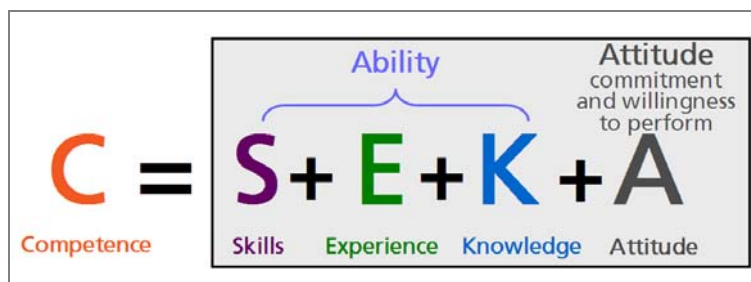


Fig.1 Components of competence

As we discuss in this paper, this definition has important consequences for how we manage competence; how we develop it, maintain it and monitor it.

2. APPROACHES TO MANAGING COMPETENCE

2.1 Supervision

The traditional approach for assessing the competence of front-line workers typically relied on the supervisory management role. To be successful this approach relied upon several assumptions:

- Supervisors were themselves experts in the field and could recognise competent performance; or, more critically, could recognise non-competent performance and could demonstrate how the task should be done
- Supervisors had sufficient time to be able to directly observe their team over a wide variety of tasks and workplace/environmental conditions

Over the last two decades there have been significant changes in how organisations structure themselves that mean these two assumptions are no longer valid; supervisory managers (if they exist at all) have increased planning and organising responsibilities and have less time to spend on the 'shop floor' and indeed may have been selected for their aptitude in these areas, reducing the likelihood that they have full experience of the tasks their staff are performing.

2.2 Exposure to training

The definition of competence used in section 1.1 has important implications for how it should be managed; 'competence' is the application of knowledge and skills and therefore its measurement requires collection of sufficient evidence of performance in the workplace. This means that simply exposing an individual to training (whether classroom or workplace-based) will not be enough to develop and assure competence. The importance of this concept was highlighted by the investigation into the Esso Gas plant explosion at Longford, Australia in 1998 where it was found that although training had been given to operators the processes for robust assessment and re-assessment were inadequate[a]. Lessons from this major incident have yet to be applied in many organisations and incidents are still occurring where training had been provided, but where assessment of the output of that training (competent performance) was absent or inadequate. Marine accidents where this was a contributory factor include:

- Foundering and capsizing of the workboat/tug *Trijnje*, Milford Docks, 1998 [1]
- Collision between the *Carrie Kate* and *Kets*, St Mawes, 2005 [2]
- Collision between the LPG carrier *Gas Monarch* and the sailing vessel *Whispa*, Lowestoft, 2007 [3]

2.3 National Vocational Qualifications

National Vocational Qualifications (NVQs) are work-related, competence-based qualifications and were created to allow individuals who may have left school with few or no academic awards to achieve recognition for performance in the workplace. NVQs are based on standards developed nationally ('National Occupational Standards') for a wide variety of occupations. The standards are statements of performance that describe what competent people in a particular occupation are expected to be able to do. They cover all the main aspects of an occupation, including current best practice, the ability to adapt to future requirements and the knowledge and understanding that underpin competent performance. Award of an NVQ indicates that the individual has the skills and knowledge needed to do a job effectively, and show that a candidate is competent in the area of work the NVQ represents [5]. Many organisations now use NVQs as an assurance of competence, however there are several significant weaknesses with NVQs that have raised concerns about their suitability for this purpose:

- They are a once-off award; there is no assurance that competence is maintained or developed
- Achievement of the NVQ award often requires the completion of mandatory and optional units; the selection of the optional units may be arbitrary and not related to the risks (or even the activities) for different sites
- They are national standards and hence need to be generic and therefore do not reflect significant differences in the same basic task (e.g. train driving) in different operating environments (it is a very different experience driving a Eurostar train at 140mph from that of a train on the London Underground network)
- They are not risk-based and are therefore likely to miss critical activities, yet include other activities which are not safety critical and which could legitimately be excluded from assessment
- By their nature they are unsuitable for use in selecting people for safety critical posts (NVQs are gained through assessing on the job performance – if the person is not yet doing that job then it will be difficult to assess their performance)
- The assessment process has historically involved gathering large portfolios of evidence with a consequently high administrative burden both for trainees and assessors
- Assessors need to be qualified to national standards, but there is no requirement for them to be occupationally competent (i.e. that they fully understand the risks and nuances of the trainee's job which may mean that assessments are less robust than they should be for safety critical roles)

The rail industry's best-practice guidance indicates that national standards should be considered when developing a competence management system, but that they "... will generally require customizing to cover the risks from degraded operations and emergencies..." [6]. This is also likely to be true for other organisations; indeed, a Health and Safety Executive research report on competence assessment for hazardous industries (relating to the Control of Major Accident Regulations) recommended that if National Occupational Standards were to be used then it was essential that the "...form of assessment and level of performance evidence collated matches the safety criticality of the site's processes, equipment and activities, particularly the rigour of on the job assessment." [10].

2.4 Recent guidance to industry on managing competence for safety critical workers

Experience from the investigation of serious incidents across many industries (rail, petrochemical, nuclear) has confirmed that many operational activities still depend on humans carrying out actions competently as a key risk control measure. Changes in the way that organisations conduct their business, including the reduction in managerial layers and the increased use of contractors means that formal arrangements for managing competence have increased in importance. In recent years the Health and Safety Executive (HSE) and the Office of Rail Regulation have issued guidance for managing competence on the railways [6] and in 2007 the HSE in association with the Institution of Engineering Technology (IET) and the British Computer Society (BCS) issued guidance for managing the competence of workers involved with electronic safety-related systems [7]. These guidance documents contain common themes for managing competence:

- Identifying work activities that require competent performance to control risks
- Using relevant performance criteria
- Monitoring competence as a routine function (i.e. not relying on once-off qualifications)
- Using assessors who are themselves competent in the activities they are assessing

These principles recognise that ‘competence’ is not just about training; effective management of competence requires links to personnel selection, training, risk management, operations management and audit. This often brings management challenges for any organisation seeking to adopt the principles as it requires communication, co-operation and co-ordination across several functional boundaries within the organisation.

3. DEVELOPMENTS IN THE RAIL INDUSTRY AND THEIR RELEVANCE TO WATERWAYS ORGANISATIONS

3.1 Development of formal competence management systems

During the last 1990’s the rail industry began to develop a more sophisticated approach to managing the competence of safety critical workers. This came as a result of major accidents such as the one at Clapham Junction in 1988 (which killed 35 passengers) and Southall in 1997 (which killed 7 and injured 150 passengers). This work culminated in the release of several industry standards and, in 2001, with the UK Health and Safety Executive’s (HSE’s) guidance for the industry on developing and managing the competence of safety critical staff [8]. This document acknowledged that national standards could not hope to address the very different risks that different types of railway operators faced. The approach recommended by HSE used a logical process and allowed organisations flexibility in how they created their management system. However, few rail organisations adopted the approach outlined in the HSE guidance in full, for a number of reasons:

- Industry mandatory standards (Railway Group Standards) did not require compliance with the HSE guidance
- The guidance was complex and did not provide a clear route to developing a competence management system
- There was little support for rail companies to assist them in developing a system

Recent changes to railway safety legislation [9] have placed a more direct link between the legislative requirements and adoption of the guidance. In addition, the guidance has been updated and amended to take account of the experiences of rail industry organisations and recent industry research in this area.

3.2 Safety critical work

This recent railway safety legislation [9] has also defined operational activities that are ‘safety critical’; an individual required to perform any of these activities must have their competence managed within a formal system. The activities are:

- Driving or controlling the movement of rail vehicles (includes conductor and pilotman)
- Signalling and controlling movements (i.e. through the operation of points, level crossing equipment)
- Communication that affects the movement of trains or switching of traction current

- Maintenance, inspection, modification and repair of rail vehicles, railway infrastructure, signalling equipment, telecommunication equipment, power supply equipment
- Checking vehicles are correctly and safely loaded
- Providing protection (e.g. setting up safe systems of work) for rail workers
- Practical training of any of the above activities (including coaching and assessment)

For waterways operations, similar activities exist that are arguably 'safety critical':

- Skipper/helmsman – controlling the movement of vessels
- Harbour master – regulating movements of vessels and hazardous substances within the harbour
- Pilot – assisting or controlling the movement of a vessel
- Engineers – maintenance, repair and modification of vessel equipment, civil engineering structures, navigation equipment etc
- Dock workers – loading and unloading cargo
- Boat hirers – Training, coaching and briefing of commercial and leisure users in the safe operation of vessels and waterway infrastructure (e.g. locks)

Leisure users pose a unique challenge to safe operation on UK waterways as there is little regulation of their competence. An indication of the significance of the risk that this group of users poses was recorded by the Marine Accident Investigation Branch (MAIB) in 2005. MAIB conducted a trial during the summer months, using data reported to HM Coastguard which showed that "...during the peak leisure boating season, leisure boat accidents outnumbered combined merchant and fishing vessel accidents by 3:1. In one summer month alone, leisure accidents equaled half the total number of accidents normally reported to MAIB in a whole year." [2]. The only real parallel to this type of activity in the UK rail industry is the preserved ('heritage') railway sector, often run by volunteers. However recent safety legislation [9] now requires such organisations to have equivalent safety systems to those required for main line passenger and freight operators.

3.3 Safety regulation

Enforcement and regulation of safety on the UK railways is the responsibility of a single body; Her Majesty's Railway Inspectorate (HMRI) which is part of the Office of Rail Regulation (ORR). This allows fairly consistent interpretations of the safety legislation so that a common understanding exists for what an appropriate competence management system should consist of and the different risks that are associated with rail operations of different types. This contrasts markedly with the situation on the UK waterways where there are several regulatory bodies with responsibility for enforcing safety:

- *Maritime and Coastguard Agency (MCA)* – responsible for enforcing all merchant shipping regulations in respect of occupational health and safety, the safety of vessels, safe navigation and operation (including manning levels and crew competency). Merchant shipping health and safety regulations extend to all those working on the ship, and all shipboard activities carried out by the crew under the control of the ship's master.
- *Health and Safety Executive* – has powers for enforcing the Health & Safety at Work Act for land based and offshore work activities, including loading and unloading a ship, and for all work activities carried out in a dry dock.
- *British Waterways (BW)* – navigation authority for a large proportion of UK inland waterways (navigation authorities have authority to implement vessel registration/licensing schemes and set out the rules for how vessels are to be navigated). BW is also the harbour authority for the Thames and owns Sharpness docks.
- *Environment Agency* – navigation authority for various rivers and harbour authority for Lydney docks (harbour authorities are required by the Port Marine Safety Code to implement a Safety Management System based on risk assessment to manage safety in the harbour area). The Environment Agency in conjunction with British Waterways has also established the certification scheme for boat safety (the Boat Safety Scheme) – all boats wishing to navigate Environment Agency or British Waterways' waters must now be certificated under this scheme.

- *Local Authorities* – responsible for enforcing the Health & Safety at Work Act for certain marine activities including the hiring out of pleasure craft for use on inland waters and marinas (unless the major work activity is boat building/repair). Local authorities may also be the navigation authority for stretches of inland waterway.

This large number of organisations all setting and/or enforcing safety standards has been recognised as having the potential for confusion and for inconsistency. As a result, several working groups have been established to ensure standards are applied consistently and to share good practice. Examples of such groups include the National Water Safety Forum (NWSF) and the Association of Inland Navigation Authorities (AINA).

3.4 Principles for developing and managing staff competence

A formal competence management system seeks to integrate a number of related management activities using a logical structure. Like most management systems it involves designing, planning, implementing, monitoring and reviewing. This cyclic process should lead to continued improvement in competence. As with many formal management systems, developing a system for managing competence can become a significant administrative burden unless the scope is tightly defined. Using a risk-based approach to determine which activities have a significant reliance on competence as a control measure is key to keeping the system manageable and focused on those activities with the greatest impact on performance.

In the introduction to this paper we discussed what ‘competence’ is and came up with a working definition that included skills, experience, knowledge and attitude as key components. Competence management activities (e.g. training, briefing, coaching, mentoring and assessment) must therefore touch on each of these component parts to provide a robust means of developing, maintaining and monitoring an individual’s competence, as indicated in the figure below:

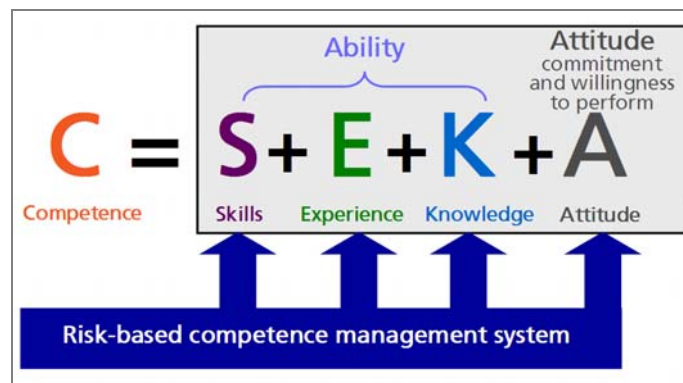


Fig.2 Relationship of management system focus to components of competence

This is significant; the methods used to develop, maintain and assess competence must be appropriate to ensure that skills, experience, knowledge and the individual’s willingness to perform competently are all adequately addressed.

The process developed for the UK rail industry to address these issues is shown in the diagram below:

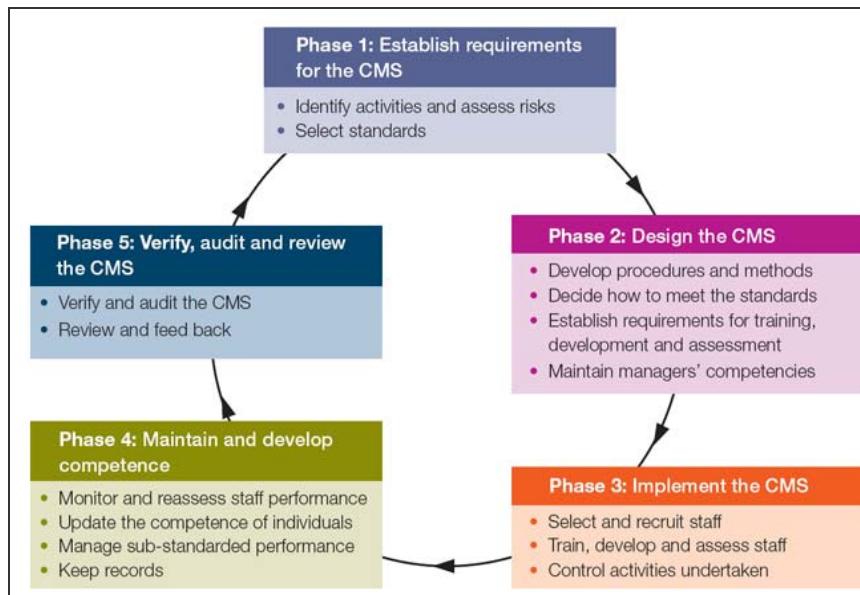


Fig.3 Competence management system cycle [6]

The first phase of this process is critical as it defines what activities rely on competence as a key risk control measure. The consequences of not paying sufficient attention to detail at this stage can be serious: safety critical activities that staff perform can be missed entirely or given the wrong priority. The knock-on effect of this is that training programmes are deficient and staff are not given the skills, knowledge and experience to deal with particular situations (often the unusual or emergency situations). This analysis of tasks and subsequent risk assessment also has important links to how competence should be developed and assessed; we discuss this in the next section.

3.5 Relationship between risk assessment, training and competence assessment

Risk assessment underpins effective competence management systems – this will ensure that the most important activities are focused on for assessment and that appropriate methods are used to assess competence. UK rail industry organisations have traditionally focused on safety risk (industry legislation requires them to do this), but there is an increasing move towards considering other types of business risk, including:

- Operating performance (service delays, cancellations, station overruns, failing to call at stations)
- Damage to assets (low speed derailments and collisions, typically in depots and sidings)
- Reputation (adverse media coverage and political intervention)

The design of competence management systems in the UK rail industry starts with an analysis of the tasks performed (as shown in Fig.3 above). Although this is a common feature of many Training Needs Analysis methodologies the approach for competence management differs in that the hazards associated with these activities (for that organisation) are then identified and the risks assessed in terms of frequency of occurrence and severity of consequence. This risk assessment process leads to the development of risk-based standards that define what ‘competent performance’ is and how this would be demonstrated in the workplace. Often, the process of developing a set of appropriate, risk-based competence standards can be quite a significant undertaking for an organisation; it may have involved the use of several workshop events involving staff who understand the activities and the use of external consultants. However, once the competence standards have been developed they become the reference for all organisational activities that require some measurement of human performance, as illustrated in Fig.4 below:

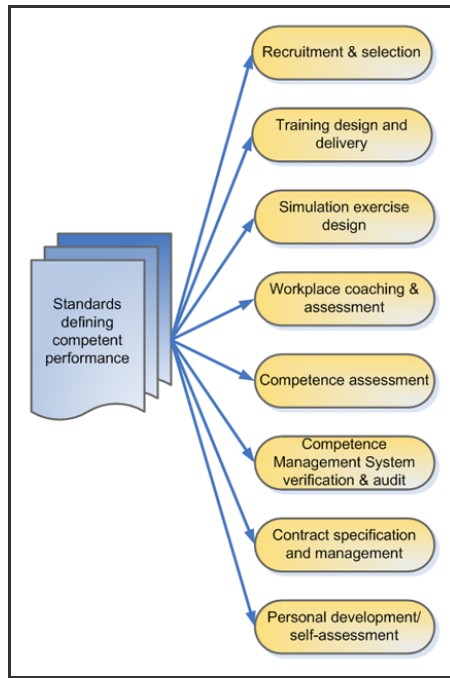


Fig.4 The relevance of competence standards

These ‘competence standards’ provide the framework for what should be included in the training package for a particular job role and the learning objectives for each session. A key part of training design is determining the priority that should be given to the various elements of a training package. Rail industry guidance [11] recommends an analysis of the task’s difficulty, importance and frequency (‘DIF’ analysis) is used to help determine this priority. The risk assessment process also provides an important input into the priority that should be given to training for each activity, as shown on the left of Fig.5 below.

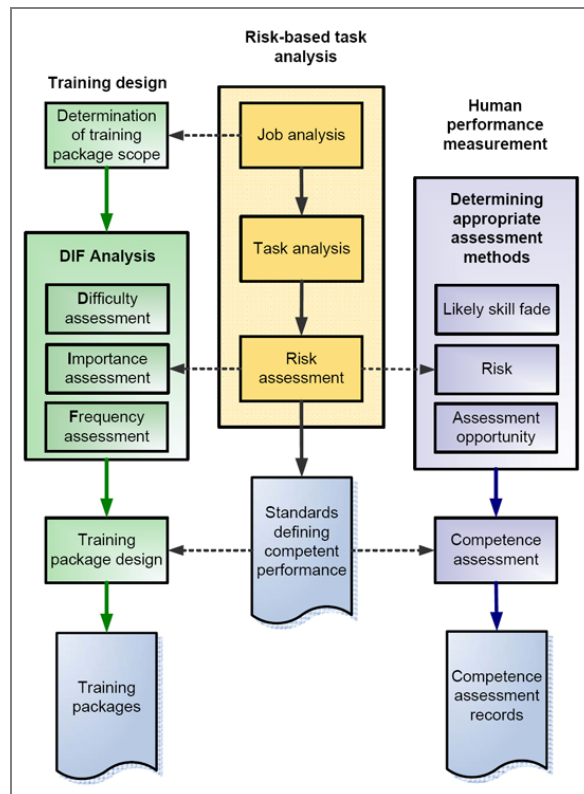


Fig.5 Relationship between risk assessment, training and competence assessment

It is logical to suggest that the level of risk associated with an activity should have a significant influence on the methods used to gain and retain competence. For example, allowing a crane operator at a busy dock to practise using this high-risk item of plant firstly with no load suspended, then progressing to manipulating an empty container during a quiet time (and during daylight) before progressing on to fully laden containers, busier times of operation, night-time working etc. For routine activities such as this, providing a structured programme of both theoretical and practical training with an appropriate assessment regime is obvious and relatively easy to achieve. However, problems often arise with the ‘out of course’ events and situations; abnormal working, degraded operations and emergency situations. Such situations are (hopefully) relatively rare and therefore there are few opportunities to practise dealing with them. Indeed, the potential for such situations may not even be identified if some form of hazard identification or risk assessment has not been carried out. Because of the perceived difficulty in building competence for such situations, many organisations resort to simply telling their employees about such situations and hoping that this will be enough to permit competent performance in the unlikely event that such a situation arises. Unfortunately this is rarely the case – a hazardous situation can be quickly and easily transformed into one where there is significant damage or loss of life through inadequate or inappropriate actions of those involved. On the UK’s waterways there many examples of this occur each year during the operation of inland waterway lock gates; perhaps ten or more boats founder in locks each year. A tragic example of this occurred in 1998 where four disabled passengers died when the Drum Major foundered in Steg Neck lock in North Yorkshire [4]. So, how can competence be developed for these rare events? The answer lies in using some form of simulation to attempt to get close to the real-life situation, but in a safe environment. ‘Simulation’ in the rail industry encompasses simple table-top scenarios and role-play as well high technology solutions such as driving cab simulators and computer-based training. A similarly broad range of approaches are used by waterways organisations from computerised vessel simulators for boatmaster training through to small models of locks used by narrow boat hirers to demonstrate the principles of lock operation.

Fig.5 also shows that there is also a link between risk assessment and competence assessment. In particular, the method used to assess competent performance should be appropriate to robustly assess whether the individual is likely to perform the task competently, consistently. Pre-announced direct observation of an individual (i.e. where the individual is informed that he/she is going to be assessed at some point in advance of the actual assessment) is probably the most commonly-used assessment method used; it allows the assessor to make reasonable judgements about an individual’s skills and experience. When direct observation is used in conjunction with open questions this provides a very powerful assessment tool. However, the weakness of direct observation is that the person being assessed is likely to modify their behaviour because they know that they are being assessed. This means that it is unlikely that a true assessment of a critical component of competence, attitude, is likely to be impossible. This indicates that there may be a hierarchy of appropriate methods, as shown in Fig.6 below:

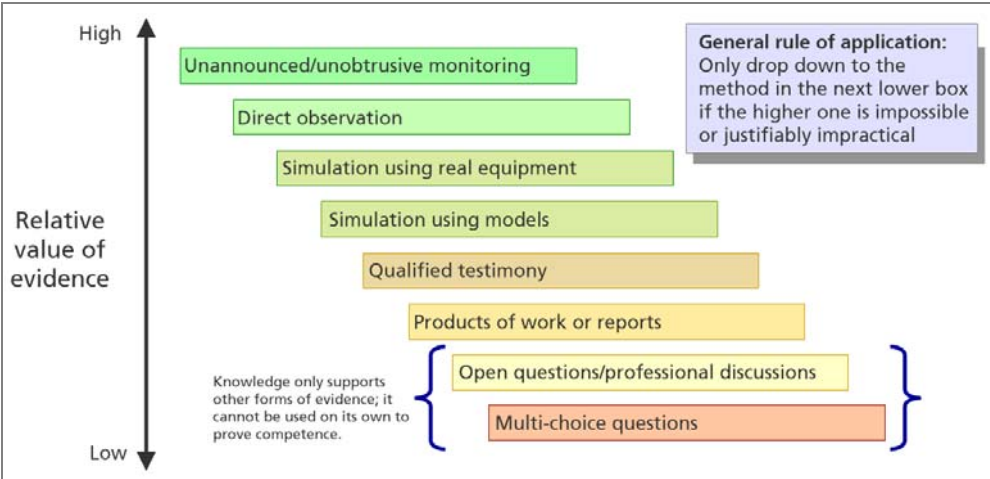


Fig.6 Relative value of different forms of assessment evidence

Using unannounced/unobtrusive monitoring and direct observation as the assessment method for all tasks could result in a significant assessment workload. The risk assessment process provides the justification for using lower quality (and less burdensome) methods for activities where the risk is low. There are also situations where observation of any sort is likely to be almost impossible to achieve; rarely-occurring activities and emergency situations for example. This provides a further input into the decision process as to which assessment method to use. A workable decision grid for assessment is shown in Fig.7 below:

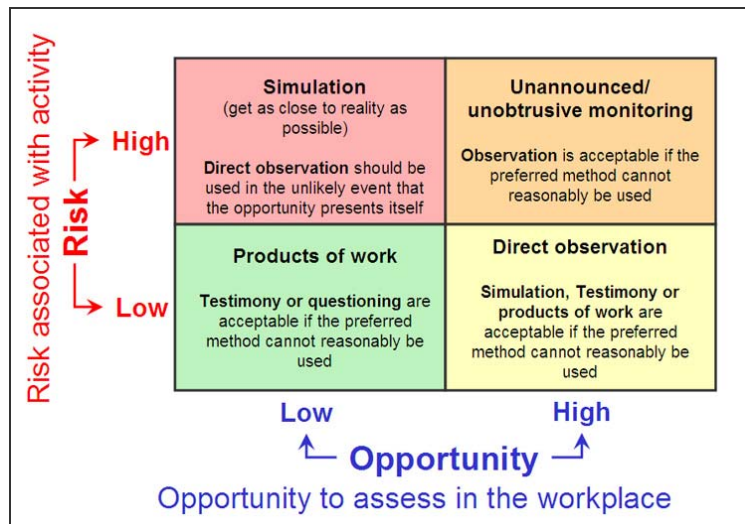


Fig.7 Assessment method decision matrix

This approach has made significant changes to how competence is assessed by rail industry organisations. Traditionally assessments were made using oral examinations or written tests, the latter sometimes consisting of multi-choice questionnaires whose value in assessing likely competent performance is negligible. Using this logical process the rail industry is increasing the emphasis on unannounced monitoring (where an individual is observed in the workplace without prior warning) and unobtrusive monitoring through the use of vehicle data recorders, signalbox voice recorders and the like. This type of monitoring is particularly useful for monitoring competence in areas such as safety critical communication where pre-announced assessment is likely to significantly modify the behaviour of the person being assessed.

3.6 Aiming for continuous assessment

The aim of the rail industry competence management principles is to provide some measure of whether an individual performs competently, consistently. This has represented a significant change from historic approaches to certification, licensing and competence assessment. Systems that rely on once-off qualifications (such as NVQs) and periodic re-licensing after an individual has initially been passed as competent is unlikely to establish a true picture of performance in the intervening time. This problem is compounded if the re-assessment event is announced to the individual before it takes place (as is common with NVQ-based systems) as the individual is very likely to modify his/her behaviour for the duration of the assessment:

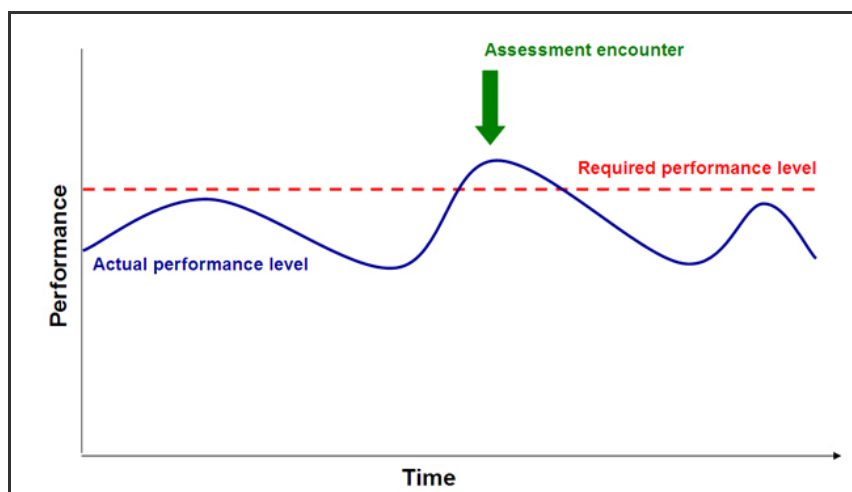


Fig.8 The effect of a single assessment encounter.

Whilst continuous assessment is likely to be impossible to achieve, a mixed programme of announced events, unannounced events and unobtrusive monitoring (e.g. reviews of reports, downloads of data or voice recorders) provides a number of ‘samples’ of performance evidence over a period of time. This is likely to allow a much more reliable (and fairer) picture of an individual’s competence to be established. This in turn allows early intervention to develop and maintain an individual’s competence before it ever becomes a significant concern. In effect this is what managers and supervisors have been doing for years – ‘managing by walking about’.

4. CONCLUSIONS

In this paper we have discussed how ‘competence’ is a complex concept with many components, each of which must be considered if human performance is to be managed effectively. Competence is still a significant factor in controlling many of the risks associated with safety critical work, particularly given the decline in on-the-job supervision and the increased use of specialist contractors. These changes and experience from several major accidents have led the rail industry to develop formal processes for developing, maintaining and monitoring the competence of its safety critical workers. This methodology requires operators to take account of the risks of their operations rather than accepting National Vocational Qualifications (NVQs) as sufficient evidence of competent performance. Whilst addressing many of the problems associated with NVQs this approach requires greater thought and linking of organisational processes (often across functional boundaries) which can be challenging to achieve. However, the risk-based approach provides clear links between hazards, operational activities and the skills, knowledge, experience and attitude that safety critical workers need to have to perform safely and properly under all working conditions. The process is continuous, rather than once-off, and uses assessment methods that are proportionate to the risk and are likely to be valid indicators of consistent competent performance.

The rail industry’s risk-based approach requires member organisations to have a common perception of ‘risk’. This seems to be achievable in this industry given that there is a single safety regulator (ORR) and the national (as opposed to international) nature of the industry’s operations. Such an approach would be less likely to control human performance risks effectively if operations crossed many international boundaries with each national culture having different interpretations of risk. Therefore such an approach is unlikely to be useful in a marine context for boat masters and indeed the recent changes to the boatmasters’ licensing [12] now provide a detailed and prescriptive set of requirements to ensure common standards are adopted across international boundaries. However, there are other waterways operations that have similarities with railway ‘safety critical’ activities and where a risk-based approach to managing competence may bring safety benefits. Such operations include dock/port working, leisure hire and engineering activities.

ACKNOWLEDGEMENTS

The authors would like to thank the Maritime & Coastguard Agency, British Waterways and the Bristol Port Company for their assistance in providing insights into risk areas that the industry faces and the controls that they have implemented.

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