Jan de Kroes Lecture

The Power of Behaviour: Non-Technical Skills

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Recent investigations into major safety failures in industry (e.g. *Deepwater Horizon*, President's Commission 2011) and in hospitals (e.g. Mid Staffordshire NHS Foundation Trust, Francis Inquiry, 2010; 2013) have renewed interest in whether behavioural sciences can provide insights that can be translated into interventions to improve the safety culture. The most powerful way to change the safety culture in a workplace is to change the behaviour of the people who work in the organization. Culture is represented by 'normal behaviour' – that is how people normally behave as they carry out their duties and respond to the daily challenges of their work environment. The best developed safety intervention, based on a scientific analysis of the behaviours enhancing or limiting human performance, is Crew Resource Management (CRM) which focuses on non-technical skills. In this presentation, I will argue that a non-technical skills approach (to facilitate the adoption of safer and more efficient behaviours), is one of the most effective methods of changing what constitutes 'normal behaviour' in a workplace.

By way of background, the section below gives an overview of the CRM approach for non-technical skills training and assessment, as used in aviation and other industries. A key factor in the successful implementation of such programmes is the prevailing organisational culture, as well as senior management support. In the second section, I outline two new studies, from the aviation and energy sectors, that are attempting to identify leadership behaviours of senior managers that may influence the safety culture and thus support the introduction of CRM.

1. Crew Resource Management and Non-Technical Skills

The term 'Crew Resource Management' (CRM) originated in the aviation industry and refers to a type of behavioural training course introduced by the airlines for pilots. It focuses on the non-technical skills that pilots require to execute a flight safely and efficiently, in addition to their technical flying skills. The CRM courses were initially called Cockpit Resource Management, later amended to Crew Resource Management (CRM) as other crew members e.g. cabin attendants, became involved. Crew Resource Management has been defined as *'a management system which makes optimum use of all available resources – equipment, procedures and people – to promote safety and enhance efficiency of flightdeck operations'* (CAA, 2006, p1). The aviation CRM courses are designed to enable flight crew members to improve their skills in teamwork, leadership, situation awareness and decision making (Kanki et al, 2010). The CRM concept has since been successfully translated to a wide range of other higher hazard industries, such as the fire services, marine, and medicine.

The related term 'non-technical skills' (also called CRM skills) came from the European aviation industry regulator in the 1990s (JAA, now EASA) in relation to an individual pilot's skills. The term non-technical skills (NTS) is now used in several safety-critical occupations and has been defined as *'the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance'* (Flin, O'Connor & Crichton, 2008, p1). These are not new skills or unfamiliar to most workers: they are essentially what the best practitioners do in order to achieve consistently high performance.

1.1 CRM in Aviation

The CRM approach was instigated after a series of major aviation accidents, without primary technical cause, forced investigators to look for other contributing factors. The best known is the Tenerife crash (1977), when two jumbo jets crashed on Los Rodeos airport runway, killing hundreds of passengers and crew. Other aircraft accidents occurred in the USA during the 1970s which also did not have primary technical failures: These began to be attributed to 'pilot error' rather than a lack of flying skills or technical faults. In response, an aviation industry conference (at NASA, 1979) brought together psychologists and airline pilots to work out how to address the behaviours revealed in accident investigation. One invaluable source of information was the cockpit voice recorder that had been built into jet aircraft, revealing what the flight crew said in the minutes before and during these accidents. Analysis of the conversations suggested failures in leadership, team coordination, communication breakdowns, lack of assertiveness,

inattention, inadequate decision making: problems that could be exacerbated by stress and fatigue. Research studies using task analysis methods were then commissioned by the airlines and regulators to enable aviation psychologists to identify the behaviours associated with the key non-technical skills (NTS). They ran experiments in flight deck simulators, interviewed pilots and analysed accident reports, in order to discover which behaviours either contributed to accidents or were effective in preventing adverse events (Kanki et al, 2010). Once the core NTS had been identified, the airlines designed CRM training courses to raise awareness of the importance of these skills, to provide the underpinning knowledge and to give practice for skill development. The aviation industry learnt in the early years of CRM implementation, that the required non-technical skills and hence the CRM course content had to be tailored to the cultural norms of behaviour in the country of operation (Helmreich & Merrit, 1998).

In the UK, all pilots must pass an examination in Human Performance Limitations before they can obtain their first licence (Campbell & Bagshaw, 2002). The HPL course covers psychological and physiological factors affecting a pilot's performance; thus their training in human factors and non-technical skills begins right at the start of their careers. In most countries, it is a regulatory requirement that civilian pilots must receive basic and recurrent CRM training by qualified CRM instructors (CRMI). Some regulatory authorities refer to it as non-technical skills training (CASA, 2011). The delivery method is typically a two day classroom-based course covering a standard set of topics (CAA, 2006), tailored to the particular type of aircraft and operational conditions, e.g. by drawing on corporate safety data. In the UK, the annual recurrent training covers the main CRM topics across a three cycle. In addition, the non-technical skills can be practised and debriefed in simulator sessions, known as Line Oriented Flight Training (LOFT) (CAA, 2002).

In a number of countries, including the UK and Australia, there are regulations that civilian pilots must have their CRM skills formally assessed as part of their regular licence revalidation (CAA, 2006; CASA, 2010). This assessment of non-technical skills is made by a qualified CRM examiner (CRMIE) observing the pilot flying in a crew and making ratings using a behavioural rating system, such as NOTECHS (Flin et al, 2003) which was designed for European pilots and covers situation awareness, decision making, co-operation, leadership and managerial skills. One particular strength of the aviation system is that the CRM trainers and CRM examiners must be properly qualified and approved to meet regulatory standards, and must have these qualifications revalidated on a regular basis (see CAA, 2009).

The international civil aviation organisation (ICAO, 2011) now stipulates evidence-based recurrent CRM training, as well as focusing on the qualification of CRM trainers and examiners. The European Aviation Safety Agency has recently established a 'rule making group' to review CRM training and assessment in European airlines (EASA, 2012). Increasingly, aviation CRM programmes are being integrated into the organisation's safety management system (ICAO, 2009) and it is expected that CRM training is informed by organisational safety data e.g. from incident databases. The CRM training requirements may extend to cabin crew, ramp crew, maintenance engineers, and programmes exist for air traffic controllers. Recently, auditing tools have been developed for evaluation of aviation companies' CRM programmes (Hayward, 2012). The CRM approach is now regarded as a key component in flight operations, pilot training/ licensing and the safety management system. This is in no small part due to the power and influence of the aviation regulators across the globe.

To summarise, what is distinctive about CRM programmes, compared to training discrete skills such as teamwork or leadership, is that they cover all the non-technical skills in one course and that the teaching material is based on scientific evidence (from studies of attention, group behaviour etc) and safety data (internal or industry). Notable, is that CRM training is:

- Based on current analyses from company or industry sources (e.g. reporting systems or accident data) of the non-technical skills required for safe and efficient operations and their role in recent events of concern
- Focused on the individual worker in a team setting – workers need 'portable team skills' for whatever team or crew they find themselves in on a given shift
- Not about personality but about behaviour
- Addressing behaviour in routine operations with the aim of avoiding critical incidents, as well as skills for dealing with a critical event

- Founded on current scientific research into human performance, with particular relevance to the specific work setting.

1.2 CRM beyond aviation
Today many other industries have adopted CRM and some of these are briefly outlined**.**

Energy With the exception of the nuclear power industry and some examples (e.g. high voltage control centres), there appears to have been surprisingly little adoption of CRM training in the energy sector, despite evidence that it would be appropriate (O'Connor & Flin, 2003). In the aftermath of the *Deepwater Horizon* accident, there is now a significant level of interest, with forthcoming reports on CRM for the energy industries (Energy Institute, 2013) and for wells operations (Oil & Gas Producers, 2013).

Shipping The shipping industry recognized the importance of training non-technical skills after failures in decision making, situation awareness, leadership and teamwork were shown to be contributing to major hull loss accidents. By the 1980s, bridge and engine room simulators were more widely available and Bridge Resource Management (BRM) and Engine Room Resource Management (ERM) courses began to be established to train non-technical skills (Hayward & Lowe, 2010). Many of the larger shipping companies began to introduce this training, and today two to four day courses, often including simulation exercises, are taught across the globe either in house or using external providers. Some of these courses have engine and navigation crews together in CRM training, which may be called marine or maritime resource management (MRM). The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) code published by the International Maritime Organisation has new amendments that update requirements for CRM training (STCW, 2011).
Emergency Services CRM training is used by the emergency services in North America (LeSage et al, 2011), most notably the Fire Service (Okray & Lubnau, 2004). In the UK, the paramedic service is beginning to adopt this approach by identifying key non-technical skills for paramedics when they are responding to emergency calls (Shields & Flin, 2013).

Healthcare The anaesthetists were the first to introduce CRM training into healthcare (e.g. Howard et al, 1992) but this has now been more widely adopted, especially for operating theatre teams, where there is some preliminary evidence of improved skills and reduced error rates (McCulloch et al, 2009). The need for a supportive organisational culture to maintain transfer of CRM skills to the worksites has also been discussed in these reports. There has also been recent research to identify and implement the use of non-technical skills ratings systems for evaluation and feedback, (e.g. NOTSS for surgeons, Yule et al 2008 www.abdn.ac.uk/iprc/notss or ANTS for anaesthetists, www.abdn.ac.uk/iprc/ants Fletcher et al 2004).

Rail A number of rail industry companies now run CRM training e.g. Queensland Rail hold RRM (Rail Resource Management) courses. A review of best practice for the introduction of RRM training and a case study of the implementation in one rail company (Dedale, 2006; 2009) identified several threats to the success of this type of programme One of these was, *'the ability to attract management commitment to, and financial support for, RRM'.* Klampfer (2012) recently described the experiences of a rail regulator supporting a National Rail Resource Management programme. She emphasised the need for senior management support and to integrate the training within the broader safety systems of the organisation. The UK Rail Safety and Standards Board recommends CRM training for maintenance crews. (www.rssb.co.uk).

1.3 Evaluating CRM
Despite the widespread use of CRM training in aviation and beyond, the scientific literature contains relatively few studies in which the impact of the training has been evaluated. Reviews of the studies measuring the effects of CRM training have shown it to produce: 1. positive reactions to the training, 2. more favourable attitudes in relation to safety relevant behaviours/ safety culture, 3. gains in knowledge of CRM skills and human performance limitations, 4. desired behavioural changes shown in a simulated or real environments. Most of the studies have come from aviation or military settings (O'Connor et al, 2002; 2008; Salas et al, 2001; 2006) but there are other domains represented, such as the automotive industry (Marquardt et al, 2010). Demonstrating effects on accident rates is very difficult in sectors with extremely low rates such as aviation. Some of the recent medical studies are now indicating improvements in performance after elements of CRM training (Wolf et al, 2010). There are also powerful anecdotal

accounts from airline pilots who have credited CRM training for helping them to demonstrate very high levels of crew performance in extreme situations (e.g. Haynes, 1992; Sullenberger, 2010).

1.4 What has CRM to do with safety culture?

Essentially organizational culture is about how people normally behave at the work site. You change culture by changing behaviors and thus establish new norms for which behaviours are accepted by the workforce and which are not. The aim is to encourage workers to use behaviours that are known to be protective for safety, such as checking shared comprehension, speaking up, challenging unsafe actions, identifying errors, protecting others' situation awareness. And – to discourage unsafe behaviors such as violating procedures, distracting colleagues, poor communication, and not discussing decisions. Thus, acceptable standards of behaviour are more likely to maintained, reducing the chance of 'risky shift', 'normalisation of deviance' and 'drift into failure'. As mentioned above, studies of CRM show positive changes after training in the attitudes that drive behaviour (e.g. data from safety culture surveys), as well as desirable changes in the behaviors themselves. Airline captains say that the culture on flight decks changed as a result of the CRM training – although it took a good few years to achieve this

Of course, CRM is not a quick fix or a magic bullet to cure a very unsafe organisation. Recent lessons from healthcare offer a note of caution for companies rushing to implement CRM training. There has been growing concern about the rates of adverse events to hospital patients – typically about 10% of admissions. These are iatrogenic injuries (e.g. wrong medication, wrong site surgery) that are caused by the healthcare system. It was calculated that about half of them were probably preventable – a finding that resulted in most countries instigating measures to improve patient safety. Healthcare organizations have been advised to adapt human error management techniques, such as CRM training. One study in England devised CRM training for surgical teams working in operating rooms. The trainers, from aviation and surgery, spent time not only delivering training courses but engaging in follow–up support to encourage better use of the non-technical skills and activities such as pre-case briefing. What they found was that while the training appeared to be initially successful, over time and once their support activities ceased, there was a regression to the previous ways of working. They commented that the doctors were particularly resistant to changing some of their behaviors (McCulloch et al, 2009).

Why was this happening? The reason was because the prevailing workplace and professional cultures were not sufficiently supportive for the new behaviour patterns, such as speaking up, or challenging seniors or junior staff requesting pre-task briefings. It could be said that the culture was toxic for the desired behaviour changes. In medical parlance, there were antibodies present in the culture that were damaging the CRM skills.

1.5 Safety Culture for CRM

What can organizations do about the cultural factor? First, a safety culture survey should reveal where there are problems that will have to be addressed in the CRM training. These can include lack of communication between work units, supervisors condoning risk taking, non-reporting of incidents, concealment of safety issues to maintain production, inadequate supervisory leadership. Other organisational survey or audit data may be equally informative.

Secondly, there is no point investing time and money on CRM courses if middle and senior mangers simply treat this as a tick box exercise or a quick win solution. In some airlines, all the managers took the CRM training, including the most senior ones. That investment of time says something about the company safety culture. Managers can exert powerful influences on the prevailing culture depending on which behaviors they demonstrate and choose to encourage (see below). If they do not see any value in the CRM courses, or support the behaviors that have been encouraged, then that message will soon be transmitted to the workforce.

Thirdly, the CRM training will usually work best when it is delivered in house by staff knowledgeable about the site technologies and current safety issues rather than by psychologists or airline pilots (although they may be required to train the trainers). Video re-enactments of accident scenarios can be filmed with local staff as actors and then used in the CRM training to discuss the behaviors that contributed to the situation, as well as those that were protective. This embeds the training in the local work culture and makes the sessions more meaningful.

Fourth, the training is probably best delivered to trainees in groups from the same or similar worksites, although not necessarily from the same team. They will share an understanding of the risks and safety issues that they encounter and work environments can have their own particular culture.
Good CRM courses are delivered in a confidential environment where the trainees should be able to talk openly about behaviours that are typical on their sites and what may be difficult about changing them.

Fifth, the content of a CRM course should be underpinned by not only a defined set of non-technical skills for the job in question but also relevant material from previous accidents, incidents and near misses that have occurred. If these are analyzed using one of the human factors investigation tools (e.g. HFIT, Gordon et al 2003), then there should be useful information on which aspects of behaviour, working conditions and cultural practices were related to these events. This would be part of a well developed human factors approach to a safety management system, where human factors analyses of unsafe events were factored back in to the CRM training courses. This synthesis is now being advocated in health care – see for instance the Clinical Human Factors Group website www.chfg.org. CHFG was set up by an airline pilot, Martin Bromiley whose wife died in an anaesthetic accident, and resulted from his concern that the human factors approaches embedded in the culture of the airline industry were totally unknown in healthcare.

2. Senior Managers' Safety Leadership
As mentioned above, workplace behaviours do not occur in an organisational vacuum, they are influenced by workgroup norms, peer pressure and supervisor reinforcement. The safer behaviours of the non-technical skills taught on CRM courses require a supportive organisational culture before people will adopt them as normal behaviour. Key to the establishment of that culture is the behaviour of the senior managers at the top of the organization chart. Their role in safety management has been increasingly highlighted in recent organisational failures. We have seen this not only in the energy industry:

The President's Commission (2011, p218) on the *Deepwater Horizon* accident concluded, '…*Even the most inherently risky industry can be made much safer, given the right incentives and disciplined systems, sustained by committed leadership and effective training. The critical common element is an unwavering commitment to safety at the top of an organization..'*

Similarly from the Report of BP U.S. Refineries Independent Safety Review Panel, 2007
"In hindsight, the Panel believes that if [the Chief Executive] had demonstrated a comparable leadership and commitment to process safety, that leadership and commitment would likely to have resulted in a higher level of process safety performance in BP's U.S. refineries."

But also in aviation, as a member of the Columbia Accident Investigation Board aptly noted, *"Leaders must remember that what they emphasize can change an organization's stated goals and objectives. If reliability and safety are preached as "organizational bumper stickers," but leaders constantly emphasize keeping on schedule and saving money, workers will soon realize what is deemed important and change accordingly. Such was the case with the shuttle program,"* (Deal, 2004, p33).

And, more unusually, in the military:

Haddon-Cave Report (2009, p492) into mid-air refuelling accident causing the loss of an RAF Nimrod aircraft and crew. *"The fundamental failure was a failure of Leadership. As preceding Chapters have shown, lack of Leadership manifested itself in relation to the way in which the Nimrod Safety Case was handled, in the way in which warning signs and trends were not spotted, and in relation to inexorable weakening of the Airworthiness system and pervading Safety Culture generally."*

Patrick Hudson pointed out in an earlier Jan De Kroes lecture that care must be taken not to attribute sole responsibility for safety to the top managers but further scrutiny of their influence on organisational is warranted. Despite the spotlight on senior managers in major accident investigations, as well as in regulatory guidance and legislation (e.g. Corporate Manslaughter and Corporate Homicide Act (UK), 2007), there is actually very little evidence on the mechanisms of their influence on safety. I have previously suggested that they are a neglected species in safety research (Flin, 2003).

We have been conducting several studies into safety leadership skills in senior managers, using methods of task analysis as per in our non-technical skills research.

2.1 Studies of Senior Managers' Safety Leadership

Isabella Rogers has been investigating top managers' leadership behaviours in relation to safety in the energy sector for a doctoral project, sponsored by the Energy Institute. She conducted a literature review to establish the evidence base from previous research. There were only 12 empirical studies that measured relationships between senior managers' leadership and safety outcomes (e.g., injury rates, worker safety compliance). Behaviours associated with safety were extracted and categorized to show how senior managers' safety leadership has been linked to safety performance. Three key safety leadership behaviours of senior managers were identified: (1) emphasizing safety as an organizational priority, (2) establishing clear communication for safety, and (3) participating in safety activities

A series of interview studies were then undertaken with senior managers, safety managers and regulators to examine what they believed to be the most effective leadership behaviours for the achievement of organisational safety. From the literature and her interview data, she has produced a framework (Rogers, in prep) of what emerged as key categories of behaviours for senior managers' safety leadership. Each is subdivided in to elements and illustrated with exemplar behaviours. The main categories are Maintaining Risk Awareness, Leading by Example and Setting and Maintaining Safety Standards. This framework is now being developed into measures that will be tested further to provide a stronger empirical basis for this key skill.

In another PhD project, sponsored by Eurocontrol, Dr Laura Fruhen (2012) examined the components of senior managers' safety intelligence. She was particularly interested in testing the contribution of problem-solving, social competence and safety knowledge to their level of safety commitment. Senior managers (n=60) from European and North American air traffic management organisations participated in interviews and the results indicated that aspects of problem solving had a significant association with behaviours that reflect safety commitment. These were: a) the number of issues and b) information sources considered when understanding problems and c) cultural ideas generated to solve a problem. Social competence and safety knowledge did not discriminate between levels of safety commitment. Accordingly, she proposed that training and guidance for senior managers should focus on their problem-solving abilities in order to support them in demonstrating safety commitment (Fruhen et al, under review, a).

In another study (Fruhen et al under review, b), she explored senior managers' underlying interpretations of safety culture using conversational analysis. Safety culture descriptions obtained through interviews with eight senior managers from two air traffic management organisations in Europe were subjected to content analysis and linguistic analysis (using *Leximancer*). The content analysis indicated 'just culture' as a dominant theme in senior managers' thinking about safety culture. Close links between the linguistic themes 'people' and 'safety' were found in both organisations. Senior managers from Organisation 1 viewed 'management' as crucial for safety culture and the linguistic analysis suggested flatter hierarchies and communication might facilitate their approach. Organisation 2 was characterised by a focus on 'reporting culture', 'performance', 'data' and 'accountability'. The findings of the two complementary methods of analysis illustrated how the conscious, as well as the subconscious, levels of understanding safety culture might be related. She proposed that organisations may benefit from an investigation of their leaders' attitudes towards safety culture through linguistic analysis, in addition to questionnaires and other measures.

In sum from the two studies, the four safety leadership skills for senior managers we are now studying are: risk awareness, problem solving, setting standards and modelling safe behaviour.

3. Conclusion

I have suggested that CRM training, with its focus on non-technical skills, may be one method of shifting what is currently accepted as normal work behaviour towards a set of behaviour patterns that are safer and more efficient. It is important to recognize that these are not unusual skills, rather they reflect behaviours which the safest and most efficient workers use regularly and the rest of us demonstrate on a good day. With senior managers, a similar approach has been taken to identify the non-technical skills they require

for effective safety leadership. Ensuring workplace safety and avoiding major accidents are considerable challenges that require an understanding of human behaviour at all levels of the organization.

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