

It's all gone pear-shaped

Our industrial psychology contributors Mark Fleming and Ronny Lardner describe how Crew Resource Management training could assist control room teams managing emergencies

IT IS 03:00 hrs and a flare stack knock-out drum level alarm goes off, but this is inconsistent with the control panel display, which is indicating a normal level. The control room team cancels the alarm and concludes it is false. Increasing numbers of alarms start sounding. Control room operators try to cope with the situation while cancelling the alarms and by requesting a process operator to investigate. Suddenly there is a large explosion. A control room operator immediately sounds the site alarm and contacts the emergency services, the duty engineer and other members of the emergency response team. Meanwhile the other control room operator is trying to conduct a roll call of site staff. By the time the on-call engineer arrives, the emergency services are attempting to bring the fire under control. One process operator is missing. The noise in the control room is deafening with alarms sounding every second as they try to control other sections of the plant...

This scenario highlights the time pressure and workload placed on control room operators during emergencies. These events are rare, but when they do occur control room operators must have the skills to respond effectively, as their actions can make the difference between a disaster occurring or being averted.

Although our scenario appears to be specific to the chemical industry, it shares many features of incidents in other high reliability situations such as aviation, medicine, and nuclear power. The common features include: time pressure, complexity, definition of the problem, uncertainty, rapidly-changing situations, competing goals, high risk (potential loss of life), and the need for teamwork. Many organisations are now providing critical teams with Crew Resource Management (CRM) training to ensure they have the skills to respond effectively to emergencies.

CRM training was developed by the aviation industry in the USA in response to increasing evidence that a large percentage of accidents were due to crew failures, rather than technical problems. The analysis of flight cockpit recorders (the black box) revealed that the crew's inability to work effectively as a team in an emergency had a major determining factor on the outcome.



▲ Coping in an emergency is a skill which can be learnt

For example, United Airlines flight 173 crashed in Portland (USA) because it had run out of fuel as it circled the airport, while the crew tried to establish if the landing gear was down¹. This incident was particularly tragic because the analysis of the cockpit voice recorder revealed that other crewmembers were aware of the critical fuel state, but did not take action when the captain failed to respond to their concerns. The accident investigation recommended that flight crews receive training to encourage an open atmosphere conducive to effective teamwork. Specifically, the training should emphasise participative management style for captains and assertiveness training for other crew members.

Elements of CRM

Communication In an emergency, it is critical that information is passed between individuals in an accurate and efficient manner. Research indicates that closed loop communication, where the receiver confirms the message received and the sender double checks the accuracy, is particularly important in emergency situations. This has clear benefits in noisy environments where critical information is being transmitted at the same time between numerous team members.

Situational awareness Emergency situations tend to develop and change rapidly, so it is important that the emergency response team members are aware of the current status of the system and have considered likely future states. This involves continuous monitoring of the environment

(including the status of critical systems), anticipation of future states, and problem identification and diagnosis. The dynamic and time-critical nature of situational awareness is illustrated by the fast jet pilots' saying "If you know where you are now, it's too late because you were there five miles ago!"²

Stress The human physiological response to a threatening situation is to prepare the body for 'fight or flight'. This reaction has

many benefits if the situation demands physical action, for example running from an attacker, but it can reduce our capacity for mental performance. Stress could therefore have a detrimental effect on a team's ability to deal with an incident. One of the effects of stress is to cause a narrowing of attention, which may cause team members to focus exclusively on one issue and ignore other more critical issues.

Performance monitoring Members of effective teams monitor themselves and their fellow team members. They also provide – and accept – feedback.

Decision making Decision making in an emergency is qualitatively different from normal conditions, due to the increased time pressure and the poorly-defined nature of the problem. The study of how effective emergency commanders make decisions produced a model called Recognition Primed Decision model (RPD)³. Expert incident commanders make decisions by quickly recognising or diagnosing the situation and take action based on previous experience of similar situations. Subsequent decisions are based on the outcome of their initial actions. RPD requires expert knowledge, but it is a faster and more effective strategy in an emergency than generating options and selecting the most suitable.

Team working Effective teamwork is clearly important in handling an emergency situation. Individual team members need to be proficient at their role and possess team-working skills such as effective communication. Analysis of high-performance teams

revealed that members also understand their colleagues' roles and responsibilities. They can anticipate colleagues' needs in a manner likened to anticipating the 'blind pass' in basketball².

The increasing recognition of the importance of non-technical skills in dealing with emergencies led to the development of what is now known as Crew Resource Management (CRM) training. CRM includes training in the interpersonal and decision-making skills outlined above that are

required to work effectively as a team and deal with emergencies. Training courses are typically 2–3 days in duration and cover the following topics:

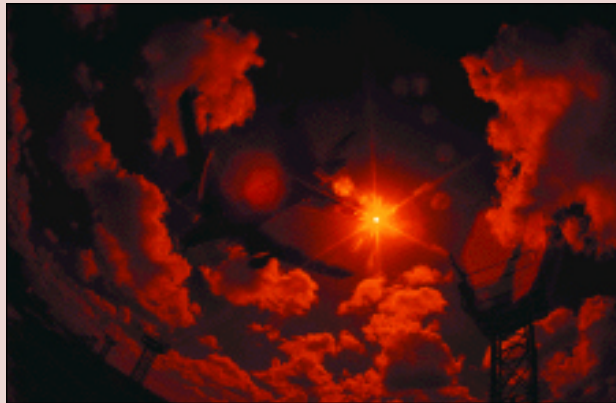
- communication skills (including listening and feedback)
- assertiveness
- situation awareness
- stress management
- performance monitoring
- decision making and problem solving
- team working.

Although CRM training was developed in aviation, it is clearly relevant to the chemical and process industries, as control room operators and emergency response teams have to be able to manage and control incidents to avert disaster. The skills required by control room operators to manage incidents are similar to those used by pilots to manage in-flight emergencies. They need to be able to work effectively as a team, cope with a high-pressure situation, accurately communicate with others to appraise them of developments and make decisions quickly based on an accurate appreciation of the situation.

Decision making

A new 737 400 on a flight from Heathrow to Belfast developed an engine fire. The pilots responded by shutting down the right hand engine. This appeared to resolve the problem. The symptoms they were experiencing disappeared, and the pilots focused on reprogramming the computer for their new destination, which was causing them some difficulty. They did not evaluate their assumptions or consider that they may have shut down the wrong engine. Any time they tried to re-evaluate their decision they were interrupted by air traffic control.

The captain informed the passengers that he had shut down the right hand engine. Survivors reported that they could clearly see that the left hand and not the right hand engine was on fire, but none of the passengers or cabin crew challenged the pilot about his decision. One survivor commented later that they thought that left and right must be different for the pilot.



As they made their approach to East Midlands airport, the damaged engine failed catastrophically and they were unable to restart the engine they had shut down. They plane crash-landed on the M1; of the 126 passengers and crew onboard, 47 lost their lives.

Impact of stress

In July 1988, the *USS Vincennes* mistakenly identified Iran Air flight 655 as a hostile aircraft about to attack, and shot it down killing all 290 people on board. At the time, the *Vincennes* was one of the US Navy's most sophisticated guided missile cruisers, with a state-of-the-art battle management system designed to protect aircraft carrier groups against air attack during major engagements. The *Vincennes* was returning from escort duty to the Persian Gulf, where US ships were on alert as intelligence reports suggested the Iranians were planning an attack to embarrass the USA around the 4th of July. On the morning of the incident, there had been a number of exchanges of fire between the US fleet and the Iranian Revolutionary Guard. This increased the workload and stress levels of operators in the *Vincennes*' combat control room. A control room operator incorrectly identified the Airbus as a probable F-14, due to an error in operating the information display system. Although the Airbus was within the commercial air corridor it was not in the middle and it was heading straight towards the *Vincennes*. Two console operators incorrectly reported that the aircraft was descending when in fact it was climbing. This information was passed to the commanding officer without confirmation from the officer responsible. The aircraft did not respond to repeated radio warnings. The speed at which this sequence of events unfolded is illustrated by the fact that the airbus was shot down only seven minutes into its flight. The investigation into this incident concluded that stress led crew members to focus too narrowly on specific tasks (task fixation). In addition, crew members' mistaken belief that an attack was under way caused them to misinterpret the information available to them to support this scenario. As a direct result of this incident, the US Navy commissioned a seven-year research project called TADMUS (Tactical Decision Making Under Stress)⁴. This project has built upon the early CRM research and has led to new developments, which are now incorporated into CRM training.

Impact of CRM

The introduction of CRM training within aviation has reduced the accident rate. This demonstrates that effective teamwork can avert imminent disaster. For example, a DC10 had a catastrophic failure of its centre engine, which resulted in the loss of all hydraulic systems and flight controls. From this hopeless situation, the crew developed their own procedure and succeeded in crash-landing the plane. 112 lives were lost, but the outcome is better measured as the saving of 184 lives from a situation where nobody would be expected to survive. The investigation concluded that the crew's effectiveness was mainly due to the CRM training it had received.

Danish shipping company Maersk introduced CRM for mariners in 1994. Since the introduction, it has seen a 33% reduction in incidents and accidents. In addition, its insurance premiums have been lowered by 15% due to the reduced accident rate. ■

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