Can HRO Principles be Applied in Practice in the Process Industries?

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Abstract

Interest in high reliability organisations (HROs) and allied concepts such as "resilience" continues to grow. Between 2009 and 2017 there was a steady increase in the number of professional and scientific publications on HRO ideas. Despite this, empirical evidence suggests the academic interest is not matched by practical implementation in process industries. How easy is it to practically apply these concepts in process safety?

This paper focuses on the experiences of an oil and gas facility whose informal organisational culture tended to discourage the reporting of process safety events such as minor hydrocarbon releases. Could HRO principles provide a more integrated approach to improving organisational practices?

The paper briefly outlines HRO concepts as described in the literature but with a specific focus on those relevant to managing loss of containment events. These include HRO themes such as "a preoccupation with failure", "sensitivity to operations", "empowering staff to abandon work on safety grounds" and "mindful leadership."

The paper will explain how a real task (shutdown planning) provided a "vehicle" to practice applying these concepts in practice. The paper describes how the training simulation was run (with two separate teams in parallel) and as it progressed the extent to which the "weak signals" included in the simulation were recognised and acted upon. The paper concludes with the results of the simulation, the reaction of the workforce involved (OIM to supervisors) and draws some conclusions on the value of this sort of training and coaching for senior managers and the offshore workforce.

Introduction

This paper describes the application of high reliability organisation (HRO) principles to an upstream offshore oil and gas facility in China. The paper briefly covers HRO practices as described in the literature but with a specific focus on those relevant to improving the approach to reducing the likelihood and significance of loss of containment events. Whilst HRO concepts are generally well known, the challenge is applying them in practice. The paper explains how a real task (shutdown planning) provided a "vehicle" to apply HRO concepts in practice in a training program. It explains the principles upon which five 2-day modules were designed and how the final 2-hour shutdown planning exercise was conducted to consolidate the training provided in previous modules. The paper illustrates how training in HRO practices can be successfully conducted if the training applies adult learning practices and is made realistic, relevant and interesting.

Background

The company's management team had international experience garnered from operations in the USA, Australia and importantly in the UK North Sea. The North Sea experience is singled out because it included both pre and post Piper Alpha disaster (1988) operations. This was important because of the radical improvements made following the disaster. Piper Alpha

effectively reframed how operations could and should be run in much of the English-speaking world (the USA being a notable exception). The major changes included the introduction of the safety case and the associated concept of "safety critical elements", as well as a focus on human factors over a wide range of topics from shift handover to leadership.

In contrast, the regulatory environment in China was akin to the prescriptive style of regulation used in the North Sea prior to Piper Alpha. As a result, there was insufficient focus on "safety critical elements" (or critical controls/barriers to use more commonly used terminology). In addition, there were some local norms and practices including a directive style of management which tended to inhibit the reporting of incidents. Both the absence of a regulatory focus on critical controls and the local norms needed to be addressed. The absence of a focus on "safety critical elements" was addressed by applying the so called "Critical Control Approach" (CCA) documented in ENFORM's A Barrier Focused Approach (2016) and described in detail in the IChemE Hazards Australia paper HA18023 (Wilkinson, 2018).

In implementing this approach, it was recognised by the company that the improvements made to the management of the barriers or controls, whilst important were not enough. The improvements made to the controls by applying the CCA needed to be complemented by suitable managerial tools and techniques. This is where HRO theory and practice came in. Could HROs provide a framework to improve the organisational environment, address the particular cultural aspects described above and provide support to the easier to define and implement program of risk control implementation? The attraction of HRO theory is that it appeared to offer a holistic set of ideas and tools with which to complement the CCA.

What are HROs?

HROs are organisations which consistently avoid serious incidents, despite operating in environments characterised by high levels of inherent risk and/or operational complexity. The US Navy's nuclear-powered aircraft carriers and submarines are usually quoted as an exemplar of a HRO. Others typically mentioned include air traffic control and air transport in general (at least in relation to scheduled passenger flying in developed countries).

The consequences of disaster in these sorts of organisations are not fundamentally dissimilar to some industrial operating environments. These include offshore oil and gas platforms, oil refineries, as well as other more obvious examples such as nuclear power stations. This has led to discussion as to whether these HRO characteristics can be transferred to other types of organisations (Lekka, 2011). This is not a simple question to answer, but it is an important one. In recent years substantial thought has gone into understanding HROs (see Figure 1) as interest in the application of HRO theory has moved into new domains including emergency medicine, health care in general and even in software development. In seeking to apply HRO theory to the practical operations of an offshore oil platform it was first necessary to be clear about the HRO principles to be applied and the method by which they would be inculcated to the management team.
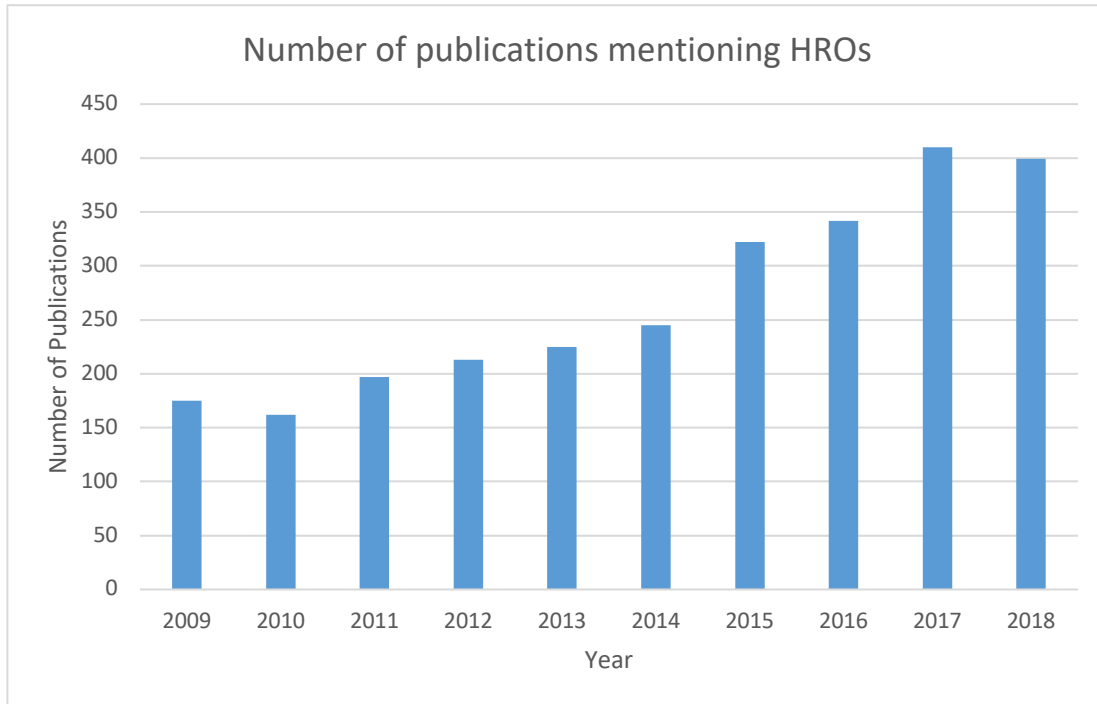
Number of publications mentioning HROs

Figure 1: Graph of number of articles published mentioning "HRO", "High Reliability Organisations" or "High Reliability Organizations" each year between 2009 and 2018. Graph was made using published papers located on the 'Web of Science' database.

What are the Characteristics of an HRO?

Research has shown that HROs have the following characteristics (Weick & Sutcliffe, 2011):

+ *A preoccupation with failure* – sometimes called "chronic unease", in this context means maintaining a healthy scepticism on how well activities are being conducted at the front line. Information on near misses and errors is sought out and learnt from as a means to improve.
+ *A reluctance to simplify* – HROs seek to identify early warning signs of failure which can be termed "weak signals." HROs avoid making inappropriate assumptions about the causes of failure, such as assigning blame to front line personnel, including individuals, when most incidents have multiple causes.
+ *Sensitivity to operations* – HROs actively seek feedback from front line personnel about what is happening in practice in their operations.
+ *Commitment to resilience* – including learning the lessons from past experience, both from within the organisation but significantly from other sectors as well.
+ *Deference to expertise* – HROs have clearly defined internal roles and responsibilities, however in emergencies expert knowledge is brought to bear, irrespective of where it comes from in the organisation.

These are all discussed later in the paper in the context of the practical training.

Adult Training Principles

A training program was designed in conjunction with the Operations Manager to provide a detailed program for all the relevant operational supervisors and managers on and offshore. Training is sometime criticised because of the difficulty of transferring classroom training to the real working environment. To increase the likelihood of participants using and applying the knowledge derived from the training in their work, we consciously applied adult learning principles (Grey & Wilkinson, 2004). In summary, these require that trainees:

+ need to know why they need to learn
+ need to be ready to learn
+ can bring their experience and knowledge "to the table"
+ can apply the learning in practice (Knowles et al., 1998).

It is asserted that adults become ready to learn the things they need to know when their real-life situations require them to. As a result, the training content was carefully examined and selected against the adult learning criteria as well as its relevance to providing training in HRO principles. In practice this meant that the training was highly participative and based on using situations commonly encountered in their daily work such as morning meetings, using real company documents or ones from similar situations elsewhere. In other words, a simulation-based approach was used which allowed mistakes to be made but in a "safe" environment so that their mistakes were not visible to their direct reports – just their peers. By practising and commenting on each other's performance they built their competence and confidence in applying these techniques.

Training Content – HRO Practices

We focused on the following HRO practices:

Rewarding the reporting of failures (Preoccupation with failure)

Reporting errors and near misses which could impact the reliability of operations is encouraged. There are many reported examples of organisations inadvertently driving reporting of near misses and actual incidents underground. After all, you cannot manage what you do not know about. Applying a *just culture*[1] approach allows reporting of failures, including human errors, while maintaining appropriate individual accountability.

Understanding the causes of unreliability (Reluctance to simplify)

HROs develop a sophisticated understanding of the causes of incidents. Most incidents are caused by a combination of factors. These include procedures not properly implemented, technical failures in equipment or software, as well as human error. HROs go beyond a simple incident model focussing on human error to understand all the contributors to incidents.

Clarity on the defences (Sensitivity to Operations)

HRO's have a heightened sensitivity to operations. In practice, HROs understand that preventing incidents requires understanding what could go wrong, identifying the critical controls (safety critical elements) or defences and making sure these are clear to the workforce.

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[1] A "Just Culture" is defined (in the context of safety) as "an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety related information – but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour." J Reason, *Managing the Risks of Organizational Accidents,* Ashgate, 1997.

Learning Lessons (Commitment to resilience)

As well as identifying defences and anticipating how they can fail, HROs put great emphasis on learning from experience. Many organisations claim to have lessons learnt processes. However, only rarely do these go beyond identifying *lessons to be learnt* as exemplified by the publication of an incident alert. A lesson is only learnt when internal processes have changed, are implemented and verified to have done so. HROs also look at incidents in other sectors which can provide insights into how they can improve. For example, we used a mining example to seek insights into how they could improve maintenance practices in their oil and gas facilities.

Effective use of expertise (Deference to expertise)

HROs have clearly defined roles and responsibilities which encourage decision taking at the front line. However, when something unexpected occurs individuals are not afraid to ask for help from those with expertise – irrespective of the organisational hierarchy (Weick & Sutcliffe, 2011). HROs "are careful not to equate expertise solely with a single expert…[and they]…also look downward toward the front line to find credible expertise" (Weick & Sutcliffe, 2011). HROs cultivate diversity, as this enables a more nuanced view of what is going on in a complex environment as well as enabling a more effective response to a challenging problem.

Table 1 provides some examples of the training applied to give effect to selected HRO practices.

Table 1: Training content applied to train on selected HRO practices.

HRO Practice	Training Content	Rationale
Chronic Unease Rewarding the reporting of failures - Preoccupation with failure	Leadership behaviours – how to react to bad news Supervisors – how to report bad news	Losses of containment regarded as failure. Fear of punishment. Risk of reporting being driven underground
Reluctance to simplify Understanding the causes of unreliability - Reluctance to simplify	How to recognise "weak signals" How to investigate effectively Why "human error was not an acceptable explanation"	Example: difficult to see interface level on sight glass on separator. Investigation revealed solids carryover into separator and equipment downstream of separator with corrosion/erosion risk
Sensitivity to operations	Leadership behaviours Importance of targeted management walk arounds Questioning skills – focus on asking detailed questions Importance of acting on weak signals and communicating the action	Tendency to manage from the office Walk arounds can be ineffective if not targeted (with scope to deal with issues as they arise). Example: Ineffective safety tour by leaders in connection with BP Macondo/Deepwater Horizon disaster

Deference to expertise
 Effective use of expertise
	Leadership Behaviours
	
	 Meeting Skills
	   + chairing skills
	   + meeting preparation
	   + ensuring participation
	   + summarising
	   + checking for agreement
	
	 Meeting skills for meeting delegates
		Directive style of leadership evident in meetings.
		
		 Training goal - ensure diverse sources of expertise are used

Shutdown Planning Simulation

As described above, a significant aspect of the program involved equipping supervisors to apply HRO concepts in practice through classroom-based learning. In addition to the individual exercises with individuals and small groups carried out over the first four modules, the training culminated in an exercise intended to bring together many of the most important HRO concepts taught over the first parts of the training. Two teams, both chaired with one of the Offshore Installation Managers (OIM), with a representative sample of Superintendents and supervisors, participated in the exercise. The ostensible task was a real one – preparation of a practical plan to operationalise the existing shutdown plan developed onshore. To do this, the real offshore team were brought together in a training room. This was done towards the end of their normal two weeks home leave. They would be going offshore immediately after this training completed for their normal two weeks offshore.

For the purposes of the training they were asked to assume they were offshore on the platform which was producing hydrocarbons. The OIM was to chair this planning meeting with a scheduled length of two hours. The meeting was to take place immediately after the usual morning meeting chaired by the OIM and attended by Superintendents and relevant supervisors.

Prior to the exercise, all attendees were provided with the paperwork they would normally expect to see at the morning meeting; production reports; the status of ongoing project work on the platform, incidents reports, shift handover notes, etc. They were asked to ensure they had carefully read this material. These documents were genuine documents from the previous days morning meeting which they had not seen. However, they had been subtly altered to include some "weak signals" which could indicate a potential future loss of containment. In addition, the team could not escape the normal interruptions inevitable on an offshore platform: telephone calls from the "beach" as calls from onshore are typically referred to; radio calls and tannoy announcements. Most of these interruptions were of no consequence. However, just as with the paperwork, these seemingly routine calls were also "seeded" with a few weak signals which could indicate an impending loss of containment. However, most of the "noise" was routine. The possibility of a loss of containment could only be identified if individuals could identify those weak signals. This required teamwork, as no one person had the complete picture.

What would be the outcome of this training? There was no sense of an impending problem in the room, apart from the directing staff who were nervous as to the outcome. Was the training too complex? Would they "join the dots" on the weak signals and even if they did, would they take any action? As the training progressed the anxiety did rise and one team decided there was potential for a serious incident and rang the Operations Manager asking him to help them decide. The other team decided towards the end of the meeting (after considerable debate and discussion) that they would shutdown and then talk to the Operations Manager. Of course, there was no right or wrong answer and the exercise debrief was arguably the most important part of the exercise where the rationale of the decisions taken or not taken were explored.

Lessons Learned

What was the result of the training in HRO principles? While the evaluation of participants pointed to effective understanding, this is difficult to prove. It is also important to note that this training was done in conjunction with a significant program to improve the identification of critical controls and to enhance their management. Consequently, disentangling the effect of the CCA

program from the HRO training is difficult. Nonetheless, there were a range of indicators that the participants had absorbed some of the practical applications of HRO principles. The company's most senior management reported that supervisors at all levels became fluent in a new common language around "weak signals" and not just in relation to losses of containment. Similarly, it was reported leadership behaviours at all levels were improved, particularly on how communications were conducted, meetings run and participation encouraged.

Summary

As has been observed before, no one gets rewarded for preventing something that hasn't happened (Repenning & Sterman, 2001). However, we did find a way to operationalise HRO practices by taking a principles-based approach and allying it with adult learning techniques. The use of a realistic simulation in a classroom setting was key to reinforcing the earlier learning and to demonstrating that HRO practices can be applied in an offshore oil and gas operation. There is now a need to see if this approach can be applied more widely and to measure its effectiveness.

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