CHEMICAL ENGINEERING TRANSACTIONS
VOL. 33, 2013
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at: www.aidic.it/cet
Guest Editors: Enrico Zio, Piero Baraldi

**ISBN** 978-88-95608-24-2; **ISSN** 1974-9791
DOI: 10.3303/CET1333075

# Human and Organisational Factors Training as a Risk Management Strategy in an Aviation Maintenance Company

Samuel Cromie*[a], Paul Liston [a], Derek Ross [a], Siobhan Corrigan [a],Lindita Vani [a], Darragh Lynch [a], Solonas Demosthenous [a], Chiara Leva [a,] Alison Kay [a], Vangelis Demosthenous[b]

[a]School of Psychology, Trinity College, Dublin 2, Ireland
[b]Kratis Training and Consulting, 37, Kyriakou Matsi Str., Flat 201, 2373 Ayios Dometios, Nicosia, Cyprus,
sdcromie@tcd.ie

Aviation has for many years been one of the leading industries in addressing human and organisational factors (HOF) within its different sectors – flight operations, air traffic control, ground operations, maintenance, etc. In particular aviation has led the way in mandating a range of measures that address HOF issues – reporting systems, shift-handover procedures, etc (e.g. UK CAA, 2003). A key element of the regulation has been the mandating of initial and continuation training in HOF for virtually all personnel working in aviation maintenance. By contrast the development of practice and regulation of risk and safety management in aviation has lagged behind process (Gambetti et al., 2012) and power (Leva et al., 2012). industries ICAO published its requirements for Safety Management in 2009 (ICAO, 2009) and these are still being translated into regulations by local aviation authorities. For example the EASA regulations require implementation of Safety Management Systems (SMS) in airlines by 2013. As a consequence of this historical sequence – the development of HOF regulations prior to safety management regulations – organisations are facing the challenge of integrating two programmes with related objectives developed to meet the requirements of different regulations. HOF training in aviation maintenance, in the European context, normally comprises of a two day initial training classroom based workshop supplemented by a one-day continuation training workshop every 2 years. The continuation training typically comprises a refresher of key HOF concepts and information about company specific challenges. E-learning and blended learning are sometimes used for continuation training, but their acceptance by the local aviation authorities is variable. This paper reports an initiative to integrate HOF continuation training within a risk management context in an aviation maintenance company.

## 1. The Organisational Context

This paper describes an initiative in an aviation maintenance company to employ HOF training as a targeted risk management intervention rather than as simply a regulatory requirement. The company carries out maintenance in three different sites employing in excess of 1500 people. HOF training was introduced into the company in 2004 and all relevant staff had received initial training by 2006. Continuation training, comprising a 2-day workshop similar to the initial training, was provided on a bi-annual basis. In 2009 a fundamental review of the quality systems was initiated partially as a result of a number of HOF events. Quality data from a range of databases within the network – incidents, voluntary reports, customer complaints, etc. - were integrated to comprise a dataset of 18,500 points. Analysis of the root causes in these data identified four underlying themes – Compliance, Process, Documentation and Competence. These themes represent organisation-level HOF hazards. This analysis led to a range of initiatives to address these hazards under a single brand. This quality programme was launched in 2009. In 2011 the employees were scheduled to undergo an iteration of HOF continuation training. However the quality department decided that rather than re-training their staff in generic HOF for maintenance, that

there was an opportunity to use the HOF training requirement to complement and enhance the quality programme to address their organisational risks. Trinity College Dublin was approached to develop, deliver and evaluate a tailored HOF training initiative to this end.

## 2. The Evaluation Programme

At the start of the project an evaluation methodology was defined with the following objectives:

- To further profile the HOF risks at operational and organisational level
- To analyse the training needs related to these challenges
- To generate content for the training
- To ensure the training was delivered effectively and adjusted efficiently as required
- To gauge the effectiveness of the training
- To provide a range of indicators of HOF risks

The methodology is adapted from Warr et al. (1972). Six different types of data were identified – Context, Input, Process, Reaction, Outcome and Performance (See Figure 1). This approach to evaluation ensures that evaluation is an integral part of the programme.

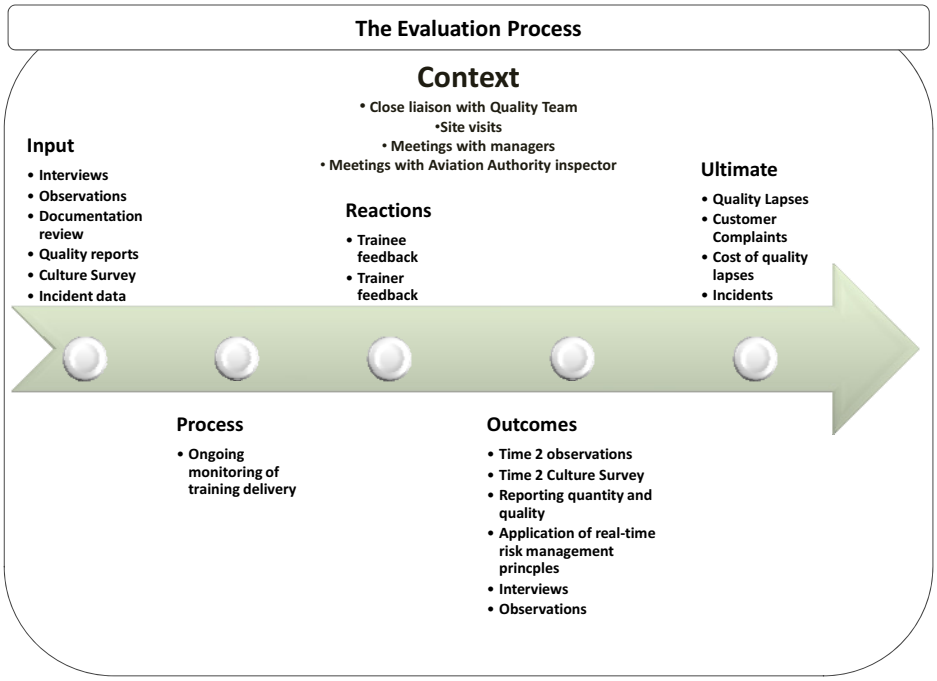


*Figure 1: The evaluation process*

**Context** information was needed in order to design a programme which would address key organisational objectives and effectively work given the current situation and previous history of the organisation. Context information included:

- Quality/safety data was – incidents, quality reports
- Previous analyses of the quality challenges facing the organisation and the hazards identified
- The other initiatives under the quality programme
- Previous HOF training
- Current HOF, safety and quality processes – reporting, procedures for addressing operational problems, etc.
- The context was also prepared through meetings with different levels of management, unions, quality teams and the aviation authority inspector.

**Input** data was required to inform and generate relevant training content. This was elicited from interviews, observations and video recordings made at each of the organisation's sites. The input data contributed directly to the content of the training programme.

During the roll-out of the training the **process** was closely monitored by the trainers and the company quality team to ensure improvements could be made as required.

Trainer and trainee **reactions** were gathered to determine how the training was received. Trainee feedback forms were completed by all trainees and verbal and written feedback was elicited from the trainers.

**Outcome** measures provide an indication of the impact of the training in the organisation in terms of perceptions, attitudes and behaviours and ultimately safety performance. There a number of safety/quality performance indicators used in the company; during the next phase of the project the impact of the project on these will be assessed. A number of organisational measures are being monitored:

- A maintenance culture survey administered in 2009 was repeated at the start of the training so as not to be contaminated by the messages in the training. The comparison of the 2009 data with the 2011/12 data provides an indication of how the culture in the organisation is changing. This will be repeated again at the end of the training to reveal any continued cultural changes associated with ongoing training and other improvement initiatives.
- In the initial evaluation visits, a total of 44 tasks were observed across the three sites using the using a tool call the "Operational Performance Audit for Maintenance" (OPAM) (Liston, 2008). The OPAM is a tool design for use in aviation maintenance to gather a holistic view of normal operations. It is not an evaluation of the individual but of the operation – are the resources available, are they used effectively, etc.
- The first e-learning module included a short survey of participant's perceptions of the adequacy of operational resources and the frequency with which they use "wobbly steps". Wobbly Steps are risky behaviours such as hurrying or not consulting procedures, which are often used to compensate for inadequate resources. A follow-up survey is planned at the end of training to gauge if perceptions have changed.
- The HOF workshops resulted in 74 suggestions being presented to managers at the end of the workshops.

## 3. The Training Strategy

In order to meet the objective of using HOF as an agent of change within the organisation, a training strategy was defined at the start to guide the development and implementation of the programme. It is depicted in Figure 2, the elements of which are explained below.

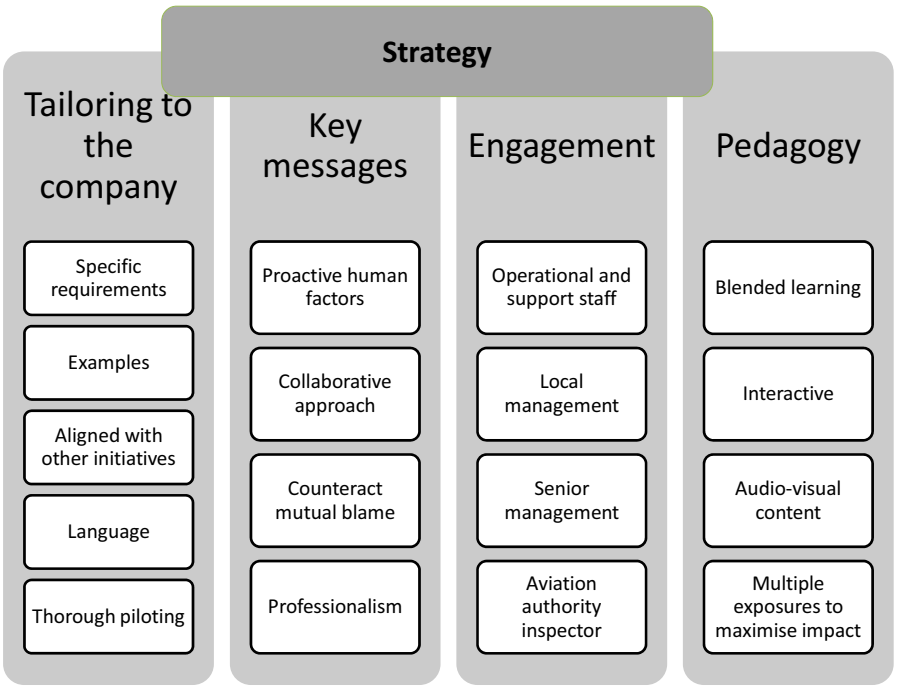


*Figure 2: The training strategy adopted.*

The training content was specifically tailored to the company in a number of ways. It was built around the company's specific requirements, both those made explicit in meetings with the quality personnel and

those derived from observations and interviews. Company specific examples were used – this included videos operational personnel in the company recounting examples of the four key hazards identified. The training was aligned with other initiatives under the quality programme – for example, providing extended training in a real-time risk management approach specified in another initiative. The terminology was carefully adjusted to that which is current within the company and the training was thoroughly piloted and adjusted according to the feedback.

To promote the objective of moving from a reactive understanding of HOF (focused on understanding of incidents and accidents), which is common in HOF training, to a proactive one, the emphasis in the training was on recognising and effectively responding to HOF hazards. The specific hazards addressed were:

- The four identified by the company in their analysis of quality data - Compliance, Documentation, Competence and Process
- Inadequate resources provided to carry out a task – equipment, tools, documentation, competence, time, etc.
- The short-cuts or potentially unsafe ways of working ("wobbly steps") that may be introduced to compensate for inadequate resources – e.g. deviation from a procedure, hurrying

The training embedded key messages for effective management of the risks represented by these hazards. To actively counter the risk that management and operational staff will explicitly or implicitly blame each other for each of these hazards, by seeking to foster a collaborative process whereby both groups acknowledge and take responsibility for their contribution to these hazards. Professionalism was identified as a key concept to be elaborated in the training, including taking responsibility, reporting, making and taking suggestions constructively.

Engagement of staff at all levels was considered important for the success of the programme. This was fostered through the delivery of targeted workshops. Engagement of local management in particular was considered critical. Managers took it in turn to participate in an engagement-with-management session in the all-employee workshops. Senior Management needed to be thoroughly engaged in the programme and were given a dedicated workshop in advance of the roll-out to the rest of the employees.

The pedagogical bases of the blended learning programme (described in the next section) are:

- To ensure consistency of delivery of the key messages through e-learning
- All training modules had a two-way interaction; the training was organised to capture the inputs of the trainees and feed them into a management process
- To deliver knowledge through e-learning so as to free up face-to-face time for interactive exercise, discussion, etc
- To provide short multiple-exposures to the content to maximise retention and facilitate the integration of knowledge into operational practice over time
- Audio visual material was developed specifically for both the e-learning and workshop components

## 4. The Training Programme

The programme is divided into three phases targeting HOF, safety management systems in the first two phases, and following up with a brief review phase to refresh the concepts and to provide an opportunity for gathering time 2 survey data, See Figure 3. Phase 1 has now been completed and phase 2 is in preparation.

Phase 1 comprised (in sequence):

- A two-hour workshop with Senior Management from all three sites. This workshop highlighted the role of senior management in fostering a positive safety culture, supporting good human factors practice, and in particular in actively promoting the HOF training.
- A 45-min e-learning module for all staff. The module introduced the key HOF concepts – the four key root causes, "wobbly steps" as HOF risks, a simple concept for effective management of HOF risks and the necessity of a collaborative "working together" approach to addressing these risks.
- A 2.5-h workshop for operational managers was designed to expose them in advance to the content their staff would be encountering in their workshops. It also prepared them for their role in the all-employees workshop.
- A 2-h workshop for all operational and support staff. This workshop was based around the same content as the e-learning module but employed the workshop format to engage the participants in collaborative exercises to explore the application of the concepts they had been introduced to.

The end of the workshop was devoted to a discussion with an operational manager. The manager's contribution was to describe what he/she had learned from their own workshop – the "wobbly steps" they can use and how they can manage their risk. The participant's role was to present to the manager one suggestion for a HOF improvement that could be tackled as a "working together" project.

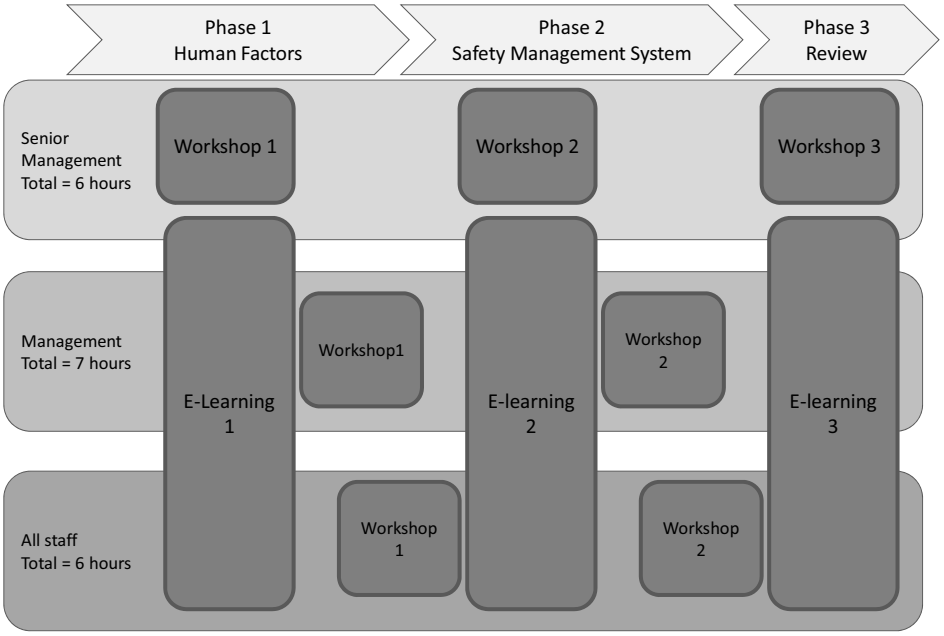


*Figure 3: A graphical representation of the training programme*

## 5. Conclusion

This paper has presented a unique approach to HOF continuation training. What is innovative about this approach and what can process industries learn from it? The key feature that is worth highlighting is the integration of HOF training with risk management:

- The training was designed specifically to address HOF risks that had been identified by the company's quality and safety data, and those that were identified in the initial profiling of the organisation.
- The training was not just about awareness and knowledge but designed to strengthen specific safety barriers – proactive risk management by individuals, collaboration in addressing problems and establishing common language about HOF risk (wobbly steps).
- Training was seen as a source of information on risk. Data was gathered through the training on organisational culture, resources and wobbly steps, suggestions for HOF improvement

Two other innovations worth noting are the integration of the evaluation strategy into the training programme and the pedagogical approach.

Has the programme been effective in meeting its objectives of enhancing the management of HOF risks in the organisation? The programme has only completed phase 1; time 2 data has not been collected on operational, organisational and outcome measures, so the impact of the programme cannot yet be assessed. Data to date, (Cromie et al., 2012), show that trainee reaction to the programme was generally very positive and many very useful suggestions came out of the workshops. In addition the trainee feedback and the workshop suggestions have highlighted areas of HOF risk that were not previously prevalent and have enabled the company to initiate specific measures to address them.

Although process industries operate in quite a different regulatory context, many of the same HOF are of concern – documentation (Agnello et al., 2012), risk communication (Di Mauro et. al., 2012). While aviation stands to learn from the approaches to risk and safety management developed in the process industries, there is much that process industries can learn from the innovations in addressing HOF risks in the aviation sector, such as the approach documented in this paper.

**References**

Agnello, P., Ansaldi, S., Bragatto, P., 2012, Plugging the Gap between Safety Documents and Workers Perception, to Prevent Accidents at Seveso Establishments, Chemical Engineering Transactions, 26, 291-296.

Cromie, S., Liston, P., Ross, D., Corrigan, S., Vani, L., Lynch, D., Demosthenous, S., Demosthenous, V., 2012, Evaluation report on Phase 1 of [The Company's] Human Factors and Safety Management Programme, Confidential report, TCD.

Di Mauro, C., Bouchon, S., Torretta, V., 2012, Industrial risk in the Lombardy region Italy : what people perceive and what are the gaps to improve the risk communication and the participatory processes, Chemical Engineering Transactions, 26, 297-302.

Gambetti, F., Casalli, A., Chisari, V., 2012, The human factor in process safety management, Chemical Engineering Transactions, 26, 279-284.

ICAO, Safety Management Manual (SMM) Second Edition Doc. 9859, 2009, Quebec: ICAO

Leva M.C., Pirani R., De Michaela M., Clancy P., 2012, Human Factors Issues and the Risk of High Voltage Equipment: Are Standards Sufficient to Ensure Safety by Design?, Chemical Engineering Transactions, 26, 273-278.

Liston, P., 2005, Human factors competence in aircraft maintenance, PhD Dissertation, TCD. U222482.

UK CAA 2003, CAP 716 Aviation Maintenance Human Factors (EASA / JAR145 Approved Organisations) Guidance Material on the UK CAA Interpretation of Part-145 Human Factors and Error Management Requirements, EASA, [Online], Available: http://www.easa.europa.eu/sms/ [22/01/2013].

Warr P.B., Rackham N., Bird M.W., 1972, Evaluation of management training: A practical framework, with cases, for evaluating training needs and results, London: Gower P.