Error Management as Organisational Strategy

Robert L. Helmreich[1]
University of Texas Aerospace Crew Research Project
Austin, Texas USA

Errare humanum est.

An anonymous Latin saying, 'To err is human' still defines a universal characteristic of our existence. While organisations can strive for a 'zero error' state, it is not an attainable goal. So long as humans function in complex environments, errors will occur. And when under stress, work overload, or work underload or boredom, the probability of error is increased. The best that organisations can hope for is to manage error effectively, decreasing the probability of errors and minimising their consequences (Helmreich & Merritt, 1998).

Psychologists have gained a thorough understanding of human error and its roots in mental processes (Reason, 1990). However, the management of error in complex systems such as aviation is an organisational task that cannot be achieved by dealing with psychological issues alone. My goal is to describe organisational strategies for error management, of which Crew Resource Management (CRM) is one important element and the vehicle for teaching error management strategies to flight crews (Helmreich & Merritt, 1998, Reason, 1997).

WHAT IS ERROR MANAGEMENT?

By error management we mean the using all available data to understand the causes of errors and taking appropriate actions, including changing policy, procedures, and special training to reduce their incidence of error and to minimise the consequences of those that do occur. Figure 1 shows the range of outcomes that crews may experience after an error is committed.

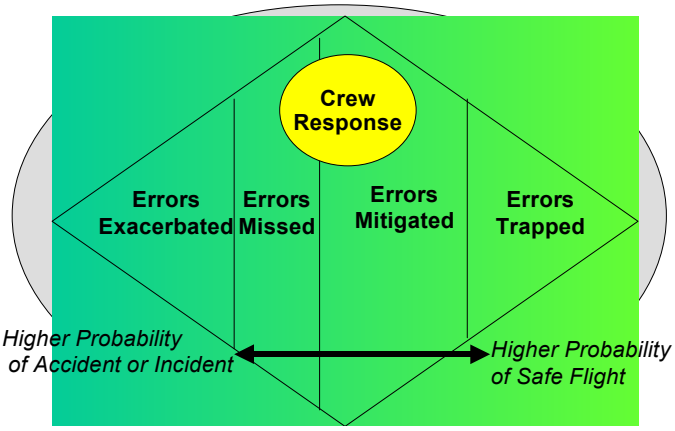

Figure 1. Outcomes of error

[1] Research supporting this paper was supported by Federal Aviation Administration Grant 92-G-017, Robert Helmreich, Principal Investigator. Figures are adapted from Helmreich & Merritt, *Culture at Work in Aviation and Medicine,* with permission of Ashgate Publishing, Aldershot, UK.

Helmreich, R.L. (1998). Error management as organisational strategy. In *Proceedings of the IATA Human Factors Seminar* (pp. 1-7). Bangkok, Thailand, April 20-22, 1998.

Error management recognises the inevitability of error and adopts a non-punitive stance toward inadvertent error. A refocused human factors training program integrates Crew Resource Management training into the error management philosophy is an essential component.

CULTURE AND ERROR

National culture and error. Flight operations occur within the context of three cultures – the national culture surrounding the organisation, the professional culture of aviators, and the company's organisational culture. Some aspects of national culture increase the probability of safe flight while others increase risk. Figure 2 shows some of the positive and negative aspects of national culture that influence the safety of flight and can be subsumed under the error management framework. Traditions of autocratic leadership, excessive individualism, and over-reliance on automation can lead to error. For example, we have found very large national differences in attitudes about the use of automated systems and instances of over-reliance on automated systems that could increase the probability of error (Sherman, Helmreich & Merritt, 1997). On the other hand, compliance with SOPs, a group orientation and scepticism regarding automation can reduce risk.

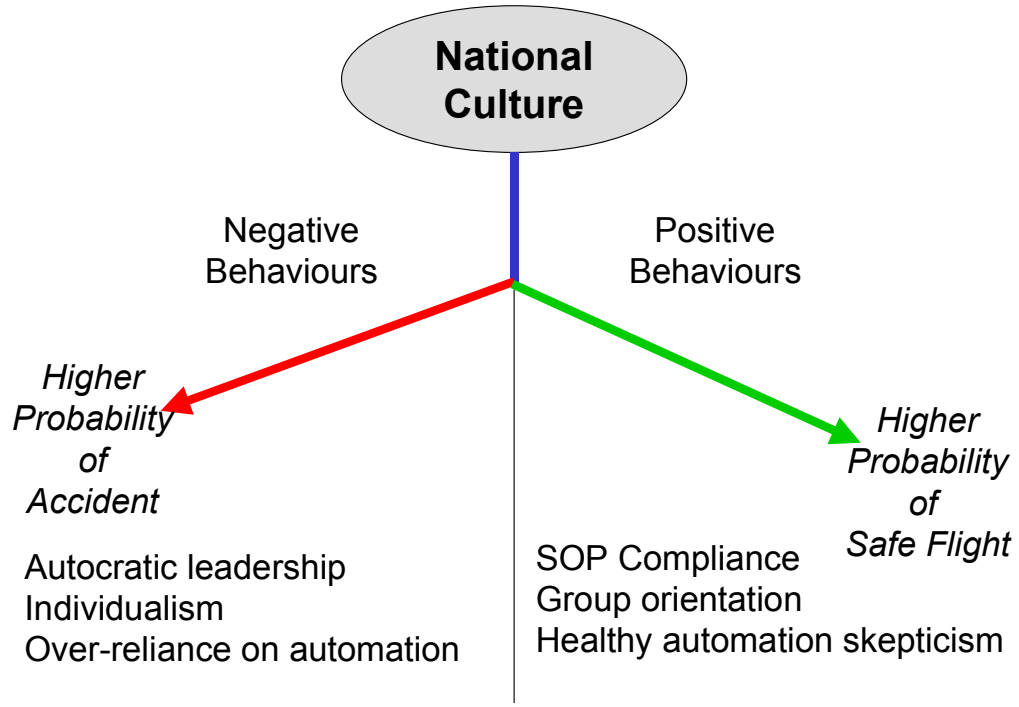

Figure 2. Influences of national culture on error

Professional culture and error. The error management approach also allows us to address one of the negative aspects of the professional culture of pilots – the universal denial of vulnerability to stressors such as fatigue, danger, and personal problems (Helmreich & Merritt, 1998). We saw as central to error management the task of convincing pilots that human error is ubiquitous and

inevitable and cracking defences against admitting to human failings. If successful, CRM should capitalise on the strengths of the professional culture, such as pride in the job and the motivation to succeed, while avoiding the negatives as shown in Figure 3. In an error-managing organisation, crews of all nationalities will have open communication regarding current actions supported by positive leadership. They will also practice full and interactive briefings and strong adherence to SOPs. *They will also profit from their errors and those of others.* Learning the lessons to be gained from errors is an essential element of error managing organisations.

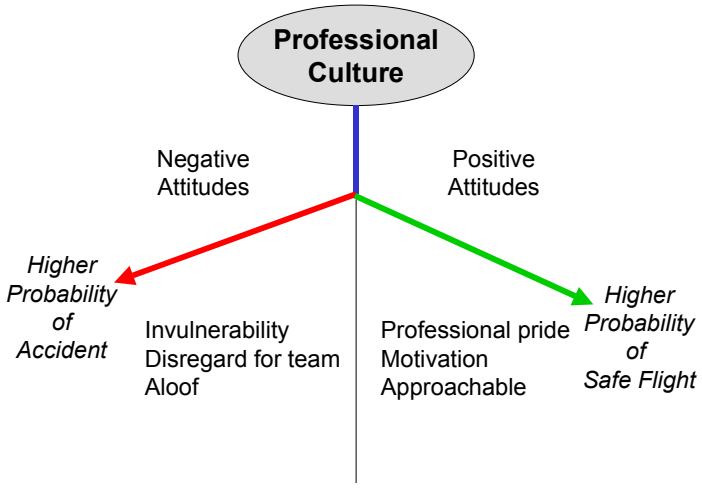

Figure 3. Professional culture and error

Organisational culture and error. Although all organisations value safety, their cultures differentially support safe practices. A safety culture (Merritt & Helmreich, 1996) is the resultant of a variety of organisational efforts. Norms of compliance with SOPs, resources available for training and maintenance, and relations between management and flight crews all influence crew behaviours and, hence, the probability of safe flight. If role models such as Fleet captains and instructors and evaluators do not demonstrate and reinforce safe practices, they are not likely to be widespread in line operations. If senior management gives only talks about safety without demonstrating commitment, the probability of error and accident will also increase. Figure 4 illustrates how cultural issues can be manifested in what Reason (1990) calls the sharp end of the organisation, the flightdeck.

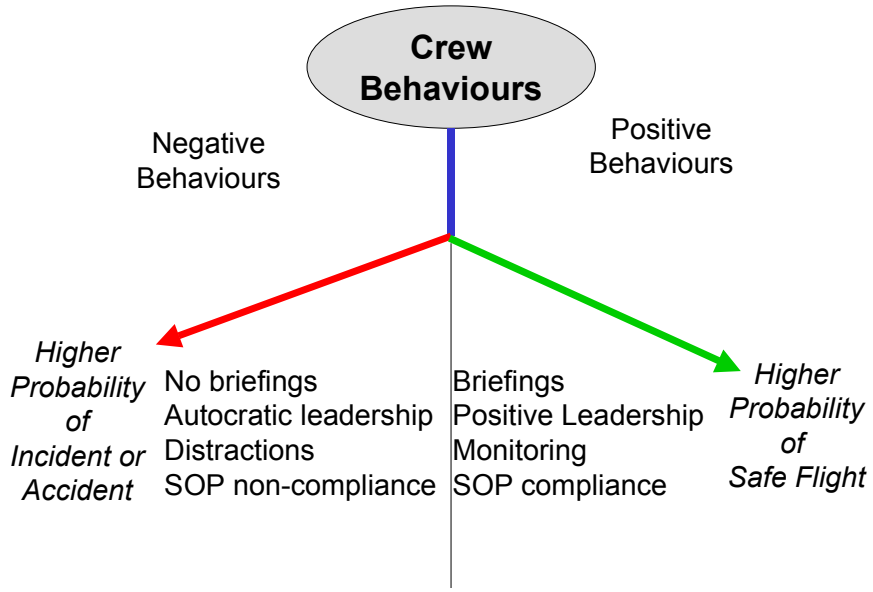

Figure 4. Crew behaviours influenced by cultures

A number of error inducing factors face any organisation. These include personal factors such as fatigue and workload, the limitations of humans as information processors, flawed procedures, maintenance errors or inadequacies, air traffic control, and simple chance. These can be thought of as the rain of errors upon crews. At the receiving end is the array of defences (or weaknesses) that organisations present. These include national culture, organisational and professional cultures (with their positive and negative aspects) and training. These are shown in Figure 5.

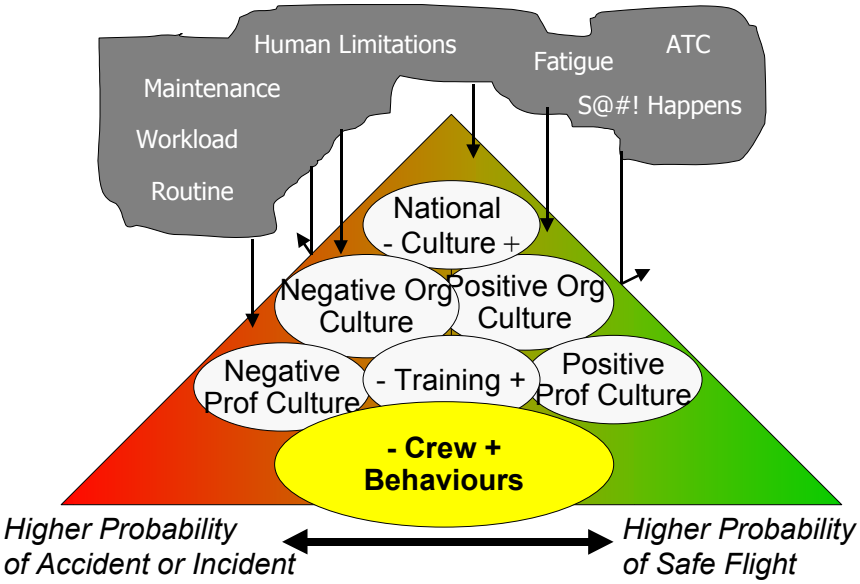

Figure 5. The rain of error

University of Texas at Austin Human Factors Research Project: 225
Helmreich, R.L. (1998). Error management as organisational strategy. In *Proceedings of the IATA Human Factors Seminar* (pp. 1-7). Bangkok, Thailand, April 20-22, 1998.

IMPLEMENTING ERROR MANAGEMENT

Successful error management places six requirements on organisations:

- Trust
- A non-punitive policy toward error
- Commitment to taking action to reduce error-inducing conditions
- Data that show the nature and types of errors occurring
- Training in error avoidance and management strategies for crews
- Training in evaluating and reinforcing error management for instructors and evaluators

These requirements are closely linked and success in coping with error requires their combined implementation. Effective error management requires trust between management and pilots regarding a shared commitment to safety. This trust can be fostered by a credible, non-punitive attitude toward errors that encourages crews to share their errors and to participate in actions to prevent recurrence. ***A non-punitive policy regarding error does not imply that any organisation can tolerate wilful violations of SOPs or regulations.*** Part of the trust also includes the belief that management will make every effort to deal with conditions that foster error.

Management must also make it clear that, in the interests of safety, it is essential that data defining the nature and frequency of errors must be available to the organisation. Without data, safety strategies only represent guesses as to what actions are needed. Evaluations conducted under jeopardy conditions (i.e., with the possible loss of certification involved) are not likely to provide a valid picture of how cockpits are managed in ordinary line operations when there is no surveillance. Strategies to obtain needed data will be discussed in the following section.

ERROR MANAGEMENT CRM (EMCRM)

Flightcrew training must also support error management. We have proposed a fifth generation of CRM that is predicated on error management. In Error Management CRM (EMCRM), the limitations of humans and the inevitability of error must be established as a baseline. Under this framework, the concepts of EMCRM can be clearly understood as countermeasures against error. The error management framework reflects a cultural universal – the avoidance of error and enhancement of safety. Strategies in support of these objectives should be more readily accepted than more vague characterisations of early CRM as techniques for enhancing teamwork.

New training for instructors and other evaluators will also be required for error management. These key personnel have served primarily as ‘error detectors’ in the past. Under the error management approach, their task is expanded to include evaluation of how errors are managed and reinforcement of effective strategies (Tullo, in press).This training needs to stress recognition of the triggers of error and understanding of how CRM practices can not only enhance error avoidance but also intervene to mitigate the severity of error outcomes. The reinforcement of error management practices in line operations is, of course, essential to the success of the strategy.

OBTAINING DATA TO SUPPORT ERROR MANAGEMENT

Line audits. We have collaborated in the conduct of line audits in a number of airlines and have analysed the data collected. It has been our experience and that of the airlines that the resultant data provide a highly accurate picture of line operations. The key to success of an audit is the credible assurance to crews that all observations are without jeopardy and that no information on any crew will be revealed to management. In practice, we have trained a group of expert observers from the airline (pilots from training, standard, the union, etc.) in the use of our Line/LOS Checklist which elicits ratings of a number of safety and CRM-related behaviours (Wilhelm & Helmreich, 1996). The team of observers then sample flights in all fleets and types of operations, usually for a period of a month. That a veridical slice of the operation is being captured is shown by the fact that observers frequently see violations of SOPs and regulations. For example, as part of a *line audit* we observed many instances of failure to complete (or even use) checklists in one fleet in one airline. We had also found that this renegade attitude in this fleet was evident in anonymous surveys of crew members. But, neither line checks nor Federal Aviation Administration inspections had suggested that this might be a problem. Our findings indicate that the line audit, in combination with other confidential sources provides an accurate picture of system strengths and weaknesses. The resulting database gives clear guidance to management on what to emphasise in training and also indicates where problems in leadership or norms may be present. Most organisations augment line audit data with confidential surveys using the Flight Management Attitudes Questionnaire (FMAQ: Merritt, Helmreich, Wilhelm, & Sherman, 1996).[2]

Analyses of the aggregated, de-identified data from line audits gives insights into ubiquitous problems such as the use of flightdeck automation as well as an indication of the variability of performance in the system (Hines, 1998).

Incident reporting systems. Incidents (which are really accidents that didn't happen) also provide invaluable information about points of potential vulnerability in the aviation system. Confidential national incident reporting systems such as the Aviation Safety Reporting System are very useful, but do not provide individual organisations with the information they need to optimise their own operations. The BASIS (British Airways Safety Information System) programme and ASAP (Air Safety Action Partnership; FAA, 1997) in the USA were designed to provide organisations with more complete data on incidents in their own operations. ASAP, for example, provides crew members with protections from regulatory or organisational reprisals under many conditions. Each reported incident is reviewed by a team (including representatives of management, the pilots' union, and the FAA) which recommends actions to prevent recurrences. Those reporting receive prompt feedback about the report and organisational response to the event. American Airlines has the longest experience with ASAP and is receiving reports at a rate of over 3,500 per year. As long as crews feel safe in submitting information to programmes such as ASAP and BASIS, the obtained data will arm organisations with an invaluable early warning system on potential threats to safety.

We also recognise the value of data collected from flight data recorders in normal operations. These data provide critical information on the nature and location of instances where

[2]The Line/LOS Checklist (LLC), the Flight Management Attitudes Questionnaire (FMAQ) and technical reports showing data collected can be found on the project's Website -- http://www.psy.utexas.edu/psy/helmreich/nasaut.htm

normal flight parameters are exceeded. The problem with recorder data is that they provide no insights into why events occurred and the human factors issues associated with them.

ENHANCING ERROR DATA

Our research project is engaged in efforts to improve data on error. One effort involves a revision of the Line/LOS Checklist, the instrument used by observers to classify crew actions in terms of observable behaviours that have been related to accidents and incidents (Wilhelm & Helmreich, 1996). The new version will identify errors and classify the tactics employed by crews to manage the errors and their outcomes.

Our second effort involves the development of a human factors checklist to allow crews to report on error in a more systematic and quantitative way. We felt that the BASIS reporting technique and other narrative reports do not elicit as much human factors information as would be desired. Our new form will be tested in one major airline in the near future and we hope to have versions for either paper and pencil reporting or electronically.

CONCLUSION

In summary, error management supported by valid data can provide a useful framework within which organisations focus efforts to enhance safety. Within this context, EMCRM should prove to be an even more valuable tool than it has been in the past. Given that the outcomes are universally valued, it should be possible to establish relationships of trust that will facilitate the effort. Regulators also must support these efforts by recognising that safety requires more than a traditional blame and punish approach to regulation of the aviation system.

Further information on the University of Texas Aerospace Crew Research Project and reprints of articles can be found on the project's homepage:
http://www.psy.utexas.edu/psy/helmreich/nasaut.htm

REFERENCES

Federal Aviation Administration (1997). Aviation safety action programs. Advisory Circular 120-66.

Helmreich, R.L., & Foushee, H.C. (1993). Why Crew Resource Management? Empirical and theoretical bases of human factors training in aviation. In E. Wiener, B. Kanki, & R. Helmreich (Eds.), *Cockpit Resource Management* (pp. 3-45). San Diego, CA: Academic Press.

Helmreich, R.L., & Merritt, A.C. (1998). *Culture at work: National, organizational, and professional influences*. Aldershot, United Kingdom: Ashgate.

Helmreich, R.L., Merritt, A.C., & Wilhelm, J.A. (in press). The evolution of Crew Resource Management. *International Journal of Aviation Psychology.*

Hines, W.E. (1998). Teams and technology: Flight crew performance in standard and automated aircraft. Unpublished doctoral dissertation. The University of Texas at Austin.

Merritt, A.C., & Helmreich, R.L. (1996). Creating and sustaining a safety culture: Some practical strategies. In B. Hayward & A. Lowe (Eds.), *Applied Aviation Psychology: Achievement, Change and Challenge* (pp. 20-26). Sydney: Avebury Aviation.

Merritt, A.C., & Helmreich, R.L. (1996). Creating and sustaining a safety culture: Some practical strategies. In B. Hayward & A. Lowe (Eds.), *Applied Aviation Psychology: Achievement, Change and Challenge* (pp. 20-26). Sydney: Avebury Aviation.

Merritt, A.C., Helmreich, R.L., Wilhelm, J.A., & Sherman, P.J. (1996). Flight Management Attitudes Questionnaire 2.0 (International) and 2.1 (USA/Anglo). The University of Texas Aerospace Crew Research Project Technical Report 96-4.

Reason, J. (1990). *Human error.* New York: Cambridge University Press.

Reason, J. (1997). *Managing the risks of organisational accidents.* Aldershot, United Kingdom: Ashgate.

Sherman, P.J., Helmreich, R.L., & Merritt, A.C. (1997). National culture and flightdeck automation: Results of a multination survey. *International Journal of Aviation Psychology, 7*(4), 311-329.

Tullo, F. (in press). Instructor/evaluator training in error management. In R.S. Jensen (Ed.), *Proceedings of the Ninth International Symposium on Aviation Psychology.* Columbus, OH: The Ohio State University.

Wilhelm, J.A., & Helmreich, R.L. (1996). The Line/LOS checklist for check pilots: A short form for evaluation of crew human factors skills in line flight settings. The University of Texas Aerospace Crew Research Project Technical Report 96-6.