Part 1: Introducing an Error Management Programme into an Organisation

Contents

1. Introducing an Error Management Programme into an Organisation

This Chapter has been adapted from "People, Practices and Procedures in Aviation Engineering and Maintenance: A practical guide to Human Factors in the Workplace."

It offers a six point plan for the introduction of a human factors programme into aircraft maintenance organisations, but especially for those which have yet to embark on a human factors programme. It should not to be regarded as a *definitive* programme which will cover all human factor areas within all companies; rather it gives a starting point and benchmark which companies may choose to adopt.

It is appreciated that many companies have already embarked upon a human factors programme, or already have elements of such a programme (eg. within their Quality System). This guidance material might be useful to act as a checklist to see whether any of the elements are missing in the existing programme and if so, why? It might also act as a reminder of the reason why each element is important, as there is sometimes a tendency for the original reasons for initiatives to be forgotten once the detail of running the programme takes over.

The six key steps are:

- Know why you are embarking on a human factors programme, and gather evidence to support the need for such an initiative.
- Obtain top management commitment to improving Human Factors awareness and performance within the aircraft maintenance system.
- Conduct a review of the current culture, procedures, systems and work practices within aircraft maintenance
- Communicate the report findings to all personnel. Human factors general awareness briefings should then be provided to reinforce the need for any change.
- Implement a change programme and conduct Maintenance Resource Management (MRM) training.
- Develop an evaluation and monitoring programme.

It is important to know why you are doing this, and to have belief and commitment that implementing such a programme, or elements of the programme, ***will*** improve safety. It is not enough simply to do it because it meets a regulatory requirement. If this is the only reason, and there is no true belief and support that such a programme is necessary, it is likely that this message will filter down to the workforce and the programme will not be effective. Many such initiatives succeed because they have a "champion" - usually someone at senior management level within the organisation who has personal commitment to the success of the human factors programme.

It is also important to consider this as a long-term initiative, and not just a temporary "fashion". There is often a great deal of enthusiasm at the start of such programmes, but this enthusiasm may tail off if the management or workforce see no positive changes arising as a result. Feedback is vital to the continued success of a human factors programme. Care should also be taken to ensure that a maintenance error management programme is not a 'victim of its own success'. Some programmes have failed because there has been such a positive response from the workforce after training, and an associated increase in reporting of problem areas and

errors, that the programme and those responsible for running it, have been overwhelmed with workload and collapsed as a result. Resourcing such a programme is discussed later.

There may also be support from the senior management team until there is a conflict of interest between commercial drivers and recommendations arising from the human factors programme. This is the real test of management commitment, and can result in the failure of the programme if commercial issues are seen to take precedence over safety issues. Whilst it is appreciated that every organisation is in the business to make money, the balance has to be appropriate between commercial and safety objectives. Professor James Reason describes this well in his book "Managing the Risks of Organisational Accidents"

1.1 Prepare your case

Know why you are doing this - to improve safety - and prepare your case to persuade those who need to be persuaded - senior management, accountants, workforce, unions, etc. 'Selling' the area of human factors to the top management structure is an important issue here. You must ensure that you can provide an understandable definition of human factors and provide links to your own human factors problems. Just quoting the saying, "If you think safety is expensive you want to try an accident!" may not be enough. Contacting other companies in order to determine the effectiveness of their human factors programmes or projects can also be quite useful. You should prepare a 'sales pitch' using Return on Investment (ROI) evidence where appropriate and/or using a recent incident, preferably from your own organisation, to present to the management. It is important to keep management interest and commitment for long enough for the programme to start proving itself successful, which may not be for a year or two.

The information on accidents and incidents contained in Part 3, Chapter 3. This chapter will be useful to help you formulate your case.

Whilst the main reason for implementing such a programme should always be safety, the argument used to justify its need or continued existence might include:

- Existing or future ICAO requirement (which, in turn, should exist to promote safety)
- Existing or future JAA requirement (which, in turn, should exist to promote safety)
- Existing or future NAA requirement (which, in turn, should exist to promote safety)
- Human Factors and error management should be an integral part of any SMS initiative.
- Some of the Health and Safety legislation may also be useful in supporting such a programme
- Evidence from well-known accident and incidents that human factors problems exist
- Evidence from own accident, incidents and anecdotes that human factors problems exist
- Evidence from research and case studies that human factors problems can be addressed
- Return on Investment arguments, based on US case-studies, that human factors programmes can not only improve safety but can save money in the long run.

More information on Return on Investment (ROI) case studies can be found on the website *hfskyway.faa.gov*.

It will also be useful at this point to develop a framework document suggesting where in the organisation the error management co-ordination responsibilities will lie, from responsibility at top management level to the day-to-day responsibility of implementing the programme, running any courses, investigating incidents, etc. There are likely to be resourcing implication,

so a strong case needs to be made if the adoption of an error management programme is going to need additional staff. It may be the case that the programme can be implemented and run, at least initially, by existing staff, until its worth is proven to the extent where a case can be made for additional staff. Some performance indicators should be agreed whereby the new team can shift focus to their new role as it develops (which it will). The programme is not likely to be effective if it is merely added to the existing burden of an unwilling and probably already overstretched Quality Manager, nor is it likely to succeed if it is 'contracted out' to a training agency which knows nothing about the workings of your organisation. It must be stressed that in order for the programme to succeed, it must be properly resourced.

1.2 Obtain top management commitment to improving Human Factors awareness and performance.

This commitment must come from the highest level of the company i.e., the Chairman, Chief Executive or Managing Director and would be supported by the Operating Board and the senior management structure. The statement of commitment could take the form of a simple letter briefly defining the terms 'human factors' and 'error management' and giving a general commitment towards increasing the company's awareness or performance with regard to human factors issues. Alternatively, it could be a detailed human factors plan with specific commitments and timescales.

The commitment must be communicated and demonstrated to all employees within the organisation - as all departments will have some impact on aircraft maintenance human factor issues - and would be continually reinforced by departmental communications such as team briefings, meetings, internal memos, etc. Commitment needs to be long term, and it needs to be emphasised that this is not just the latest management 'fad'. It should be stressed that "this is the way we do business from now on".

1.3 Conduct a review of the current culture, procedures, systems and work practices within the engineering and maintenance function.

As far as the culture is concerned the first question to consider is whether the workforce feel able to report incidents of human error without incurring disciplinary sanctions and penalties. In other words is it a 'just culture' where reported human error is tolerated - in the interests of safety - but reckless behaviour is not, or are people reluctant to admit to any mistake for fear of retribution? Some companies have successfully adopted an 'amnesty' programme where employees are encouraged to come forward with details of past incidents, without fear of disciplinary sanction, which then paves the way for a 'just' culture in the future.

Staff surveys are a useful tool to determine what kind of culture currently. The HSE have published a report entitled "Improving Compliance with Safety Procedures: reducing industrial violations" which includes a survey tool which may be appropriate to use. Note: a software version of this tool is also available. Also, the UK Human Factors Combined Action Group (UKHFCAG) document "People, Practices and Procedures in Aviation Engineering and Maintenance: A practical guide to Human Factors in the Workplace" includes a succinct staff opinion survey (see Appendix A).

'Round Table' discussions (with managers, technicians and support staff) where people are encouraged to be open and honest about the real culture can also be very beneficial.

With regard to procedures, systems and work practices these can be reviewed by consultation with the workforce either through an amnesty programme (as mentioned above) or through a 'workplace' audit conducted jointly by management and the workforce (this latter method is strongly recommended as it will encourage the workforce to 'buy into' the human factors process from the start) or by using computer based tools like the Ergonomic Audit Programme (ERNAP). The ERNAP tool is addressed in Part 3, Appendix C of the handbook. Examples of the types of issues which should be covered in a workplace audit are included in Appendix B of Part 1.

1.4 Communicate the report findings to all personnel. Human factors general awareness briefings should then be provided to reinforce the need for any change.

The details of the audit report should be communicated to all personnel. This will then provide valuable recognition and support from the workforce during any necessary change process. Any areas of change that cannot be immediately addressed (due to commercial or operational reasons) should be discussed with the workforce at this point.

To reinforce this recognition and support all maintenance personnel - including all support personnel and sub contracting staff (and ideally all personnel within the company) - should attend short human factors briefings which will highlight the principles behind human factors and the importance, both in a commercial and safety sense, of improving the company's current performance.

These briefings would give:

- A definition of the terms 'Human Factors' and 'Error Management'.
- An overview of the aircraft incidents where a human factors error has been a contributory element.
- The current and proposed legislation with regard to human factors.
- The common types of human factors problems (taken from the audit report) that exist currently in the workplace.
- The approach which the company is adopting

These briefings should be used as an opportunity to ask the workforce what they think, ensuring that any ideas and suggestions which are offered are recorded and fed back into the process.

1.5 Implement a change programme and conduct Human Factors training if appropriate.

The audit report will have given details of any changes that need to be made and from this information a change programme should now be created. Some recommendations, such as changing the typeface on a workcard, are relatively easy to accomplish. However other recommendations, such as changing the corporate culture, are far more difficult and will require a considerable amount of background information before embarking on a change programme.

In general for any changes to be effective they must follow a SMART format. That is they should be **S**pecific - **M**easurable - **A**ttainable - **R**ealistic - and **T**imescale driven.

A typical change programme might take the following format:

1. Appointment of a Human Factors Co-ordinator. This is not necessarily a Human Factors Manager but instead a short term project manager who will guide the change process and help to allocate resources where necessary. There is a temptation when appointing a co-ordinator to look no further than the Quality Assurance Department. However rather than considering only background or current job role it may be beneficial instead to look for someone who has a strong personal interest in human factors or who has had previous experience of project work or human factors, and who is respected by the workforce. In order to gain workforce support it would also be advantageous to consult with the workforce over the final selection.

2. Consideration of resource levels, from management level to administrative support level. For instance, data will need to be entered and analysed from both the initial review and any ongoing investigations. Where possible, this function should be integrated with other existing systems and forums such as Quality/ resolution meetings, Air Safety Reporting or Continuous Improvement Programmes. Once the findings have been released the HF Co-ordinator will review solutions and strategies to any problems that are highlighted.

3. Implementation of a Human Factors Programme. This should include Human Factors training (ideally, for all of the staff, including managers, supervisors, planners, administrative staff, etc), an incident reporting scheme (if there is not such a scheme running already, or changes to an existing scheme), an incident investigation mechanism, the publication of an appropriate disciplinary policy, etc. These are covered in further detail in Chapter 2 - Maintenance Error management Systems, and Chapter 3 - Human Factors Training.

4. Development of a 'Change Plan'. The plan will include details of the changes to be made, the people responsible for implementing the changes and the specific timescales involved. Dependent on the changes that need to be made there may be a need to acquire a considerable amount of background information before developing and finalising the plan.

5. Communication of and Commitment to the Change Plan. The details of the plan should be communicated to all engineering and maintenance personnel to gain essential workforce support. In addition there should also be some demonstrable commitment to the plan, and human factors in general, from the senior management of the company

6. Implementation of the proposed changes. Once all the above elements are in place the programme can be implemented. However the process will need to be reviewed and assessed at various stages to ensure that the timescales are valid and resources are adequate.

1.6 Develop an evaluation and monitoring programme.

In order to ensure that human factors performance is increased and sustained it is important that an evaluation and monitoring programme is put into place. Regular audits should be an ongoing part of this programme which should also examine the effectiveness of any Human Factors training and whether, as a result of the changes implemented, any further changes are necessary. It is also important to start analysing the data arising from incident investigations, bearing in mind that this may only begin to show trends after a few years (depending on the size of the database).

There may well be a number of direct and tangible performance indicators that show that human factors performance has been increased; such as a distinct drop in human factors incidents! However it is far more likely that a successful programme will actually produce an initial increase in reported incidents as confidence in a 'just' environment itself increases. There are other indicators which may be less direct than the number of reported incidents. Indicators like increased staff awareness of human factors issues and increased staff morale through the introduction of a 'just' culture. All performance improvements are important but it is also important to ensure that through continual evaluation and monitoring these improvements are fully sustained.

The evaluation and monitoring programme must be linked to the change programme and specifically the change plan. In its simplest form, the evaluation and monitoring programme will look at the company's adherence to the change plan timescales and recommend alterations where necessary. However once the change plan has been fully implemented it is important to find out how effective the actual change process has been. One way to do this is by re-running the staff survey to determine the extent of the workforce's increased awareness in human factors issues.

Evaluation of the effectiveness of Human Factors training can be difficult. The attitudes can be evaluated by using post course critiques, but determining whether behaviour has actually changed (if, indeed, any change was necessary) is more difficult to measure.

Care should be taken if using incidents as a performance measure of the success of a human factors programme or human factors training. Part of the programme will encourage staff to report incidents which they may not have reported previously, so the apparent number of incidents is likely to increase in the short term. However, this may be a valuable measure in the longer term.

Good performance in human factors issues can not be sustained merely by introducing a human factors / error management programme. As the performance of people is the lifeblood of any organisation it follows that the commitment that any organisation makes to the principles of human factors and error management is one that be ongoing, and not merely a passing 'fad'.

1.7 Further reading

1. People, Practices and Procedures in Aviation Engineering and Maintenance: A practical guide to Human Factors in the Workplace. UKHFCAG. 1999. *www.raes.org.uk*
2. ATA 113 Specification for Maintenance Human Factors Program Guidelines. *http://www.air-transport.org/public/publications/57.asp*
3. Reason, J. Managing the Risks of Organisational Accidents. 1997. Ashgate
4. ICAO Human Factors Manual.
5. Maurino, D., Reason, J., Johnston, N., & Lee, R. (1995). Beyond Aviation Human Factors.
6. Meghashyam G. Electronic Ergonomic Audit System for Maintenance and Inspection. Proceedings of the Tenth Meeting on Human Factors Issues in Aircraft Maintenance and Inspection, 1996 *hfskyway.faa.gov*
7. UKCAA AWN71
8. Return on Investment ppt presentations *hfskyway.faa.gov*

2. Maintenance Error Management System (MEMS) Concepts

In order for an organisation to learn from its errors, it is important to have a system in place to detect these errors and to understand why they occurred, and to act upon the findings. Many accident and incident reports cite previous occurrences of the problem(s) which led to the accident, where organisations were either not aware of these problems or were aware and failed to act upon them. One example is the omission of O-ring seals on master chip detector seals resulting in the Eastern Airlines accident at Miami in 1983. The NTSB report cited "the failure of Eastern Airlines management to assess adequately the significance of previous occurrences and to act effectively to institute corrective action".

A Maintenance Error Management System (MEMS) should:

- create an environment where errors and problems are freely reported and investigated, without fear of inappropriate disciplinary action upon the individual or organisation
- provide a mechanism for reporting and recording errors and problems
- investigate problems to determine the root causes
- provide appropriate information to managers to assist them in carrying out appropriate action to resolve or control the causes

Issues associated with sharing of data between organisations are not addressed in this Chapter, other than to support the principles of data sharing. This Chapter provides guidelines for a MEMS as an internal company process (which may or may not be supplemented by an electronic database).

Whilst this Chapter refers to Maintenance *Error* Management Systems, it is envisaged that the MEMS process would cover all incidents, occurrences and many problem areas, the causes of which are not necessarily known when the incident or problem report first comes to light. One should not assume from the outset that the cause of an incident is human error. Applying the MEMS process to all incidents should uncover the root causes whether they are technical, environmental, procedural, human error, organisational, etc.

2.1 Just culture and disciplinary policy

In order for a MEMS to work, it is essential to gain the confidence of the workforce. Their cooperation will be vital in the investigation of incidents and the determination of the root causes.

Many organisations have a "blame and train" culture, with the primary aim of any incident investigation being to identify a "culprit" and discipline or dismiss them. However, this will rarely prevent the problem from occurring again. People do not generally set out to make mistakes. Of course, there will be a few instances where a person has been reckless or grossly negligent, in which case disciplinary action would be appropriate, but in a the professional context of aircraft maintenance, these will be the minority of cases. It is important to have a clear company disciplinary policy which states that an individual will only attract disciplinary action in specific circumstances. Those circumstances may vary slightly from company to company but in general, they should follow the guidelines given in CAA AWN71:

In the context of error management it is considered that an unpremeditated or inadvertent lapse should not incur any punitive action, but a breach of professionalism may do so. As a guideline, individuals should not attract punitive action unless:

(a) The act was intended to cause deliberate harm or damage .

(b) The person concerned does not have a constructive attitude towards complying with safe operating procedures.

(c) The person concerned knowingly violated procedures that were readily available, workable, intelligible and correct.

(d) The person concerned has been involved previously in similar lapses.

(e) The person concerned has attempted to hide their lapse or part in a mishap.

(f) The act was the result of a substantial disregard for safety.
"Substantial disregard", for this purpose, means:
-In the case of a certification authorisation holder (eg. licensed engineer or Certifying Staff) the act or failure to act was a substantial deviation from the degree of care, judgement and responsibility reasonably expected of such a person.
-In the case of a person holding no maintenance certification responsibility, the act or failure to act was a substantial deviation for the degree of care and diligence expected of a reasonable person in those circumstances.

The degree of culpability would vary depending on any mitigating circumstances that are identified as a result of the MEMS investigation. It follows that any action taken by the organisation would also be on a sliding scale varying from corrective measures such as re-training through to dismissal of the individual.

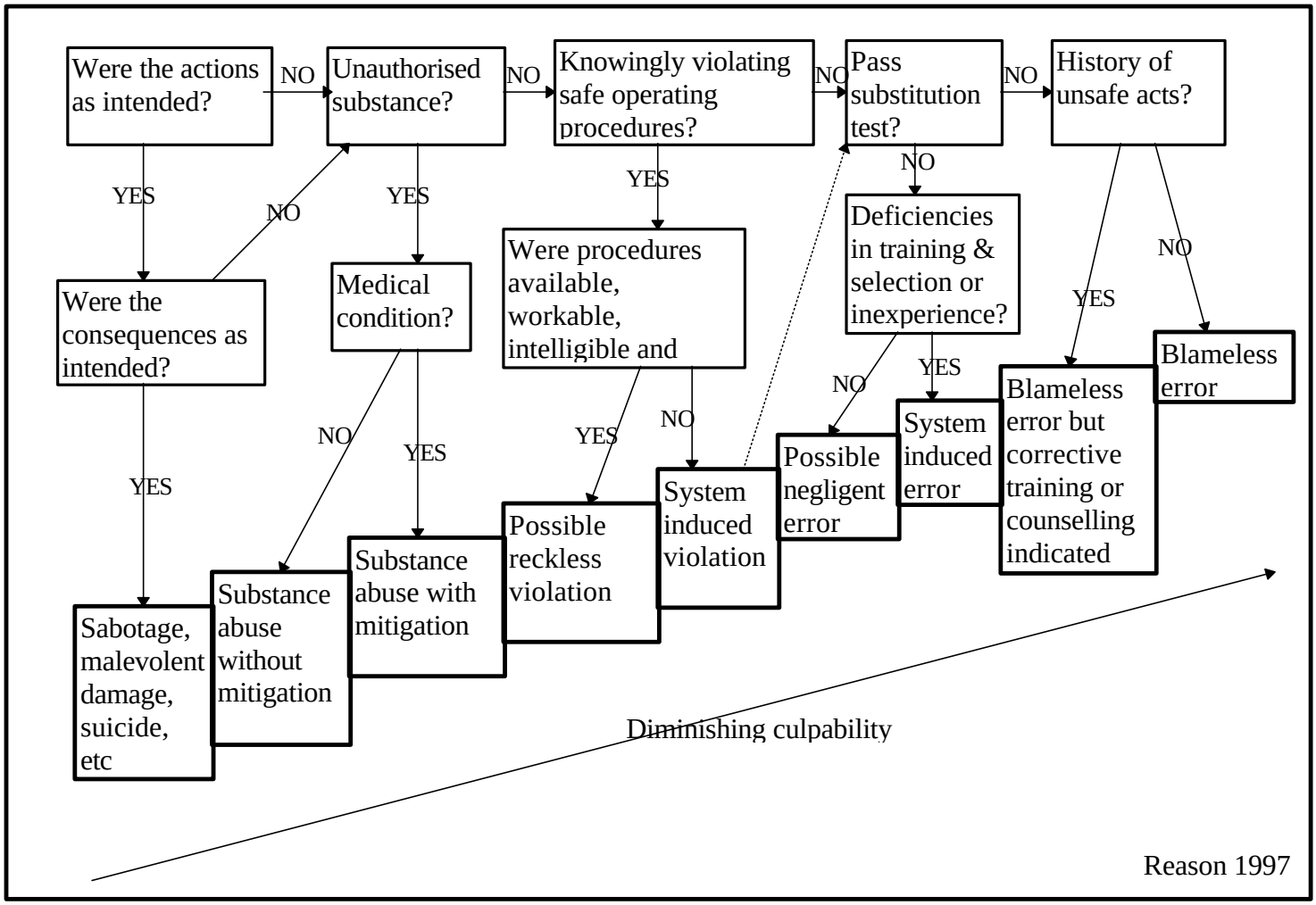
The "substitution test" is good rule of thumb when illustrating where blame is inappropriate. If an incident occurs, ask yourself whether another similar individual (with the required skill, training and experience) in the same circumstances would have done anything different. If not, then blame is definitely inappropriate. Further information on this concept can be found in the article:*"Do blame and punishment have a role in organisational risk management?". Johnston, N. Flight Deck. Spring 1995, pp 33-6.*

Professor James Reason, has produced a useful flow chart (Fig 1) to guide you as to where punitive action may be appropriate or inappropriate. It is assumed that an action or actions have contributed to an accident or serious incident. There may have been more than one individual involved, and several actions, in which case the 'decision tree' may be applied to each in turn. It is important to determine intentionality. If a deliberate action was intended to cause harm then culpability is obvious. However, as you progress from left to right along the 'decision tree' you are dealing with situations where either the action was unintended (slips and lapses) or the consequences were unintended (mistakes and violations) and culpability is diminished. However, just because the action or consequences were not intentional does not mean that the individual is not culpable, eg. if an individual was knowingly engaged in violating safe, workable operating procedures, some degree of culpability may exist.

The reader is strongly urged to read the section of Professor Reason's book *"Managing the Risks of Organisational Accidents"* which deals with these issues and describes how the 'decision tree' should be used.

This book provides an excellent reference for all aspects of error management, as do the series of videos produced by the International Federation of Airworthiness (IFA) entitled *"Engineering Solutions to Human Problems"*

Fig 1. A decision tree for determining the culpability of unsafe acts.



Further guidance on the subject of just culture and disciplinary policies can be found in the paper *"The Link between Employee Mishap Culpability and Aviation Safety". Marx, D. Jan 1998. Hfskyway.*

2.2 Support from the top

A MEMS is unlikely to be successful unless it receives support from the very top level in any organisation, and seen to be supported by senior management in practice - not just words- at all times. A MEMS is a long term commitment, not a quick fix, and it is very easy for initial enthusiasm to wane after a few months or years and for the system to fall into disuse.

A manager should be appointed to have responsibility for the successful functioning of the company MEMS, with this manager being senior enough in the organisation to ensure that, when causes of problem are identified, responsibility for addressing those issues is assigned to

appropriate individuals or Departments. This person would not necessarily be the same person responsible for the development and day-to-day running of the programme.

A MEMS will not succeed if is becomes merely a depository for data; it needs to be a closed-loop process with problem being acted upon and feedback provided to employees concerning results.

2.3 MEMS concepts

When considering whether or not to implement a formal MEMS, an organisation should bear in mind the following considerations (as listed by Professor James Reason, 1997):

- *Human fallibility can be moderated up to a point, but it can never be e1iminated entirely. It is a fixed part of the human condition, partly because errors, in many contexts, serve a useful function (for example, trial-and-error 1earning in knowledge-based situations).*
- *Different error types have different psychological mechanisms, occur in different parts of the organization and require different methods of management.*
- *Safety-critical errors happen at all levels of the system, not just at the sharp end.*
- *Measures that involve sanctions, threats, fear, appeals and the like have only a very limited effectiveness. And, in many cases, they can do more harm – to morale, self-respect and a sense of justice – than good.*
- *Errors are a product of a chain of causes in which the precipitating psychological factors – momentary inattention, misjudgement, forgetfulness, preoccupation – are often the last and least manageable links in the chain.*
- *The evidence from a large number of accident inquiries indicates that bad events are more often the result of error-prone situations and error-prone activities than they are of error-prone people. Such people do, of course, exist, but they seldom remain at the hazardous sharp end for very long, Quite often, they get promoted to management.*

A MEMS should address (i) the reduction of errors and (ii) the containment of errors. It should include (according to Reason, 1997):

- *Measures to minimise the error liability of the individual or team.*
- *Measures to reduce the error vulnerability of particular tasks or task elements.*
- *Measures to discover, assess and then eliminate error-producing (and violation-producing) factors within the workplace.*
- *Measures to diagnose organisational factors that create error-producing factors within the individual, the team, the task or the workplace.*
- *Measures to enhance error detection.*
- *Measures to increase the error tolerance of the workplace or system.*
- *Measures to make latent conditions more visible to those who operate and manage the system.*
- *Measures to improve the organisation's intrinsic resistance to human fallibility.*

Although the initial identification and reporting of problems, occurrences/ incidents is not specifically addressed within most MEMS methods, it is an intrinsic and important part of the whole system. An incident, by its very nature, generally identifies itself in that the consequences are such that many people know about it and action needs to be taken. However, more minor occurrences and problems may not be so visible and it is important to have a system where these are identified in order to trigger the MEMS process, and to initiate investigation if appropriate. Most organisations have some form of internal incident reporting

scheme which would identify many of the more significant occurrences, but not necessarily the lower-level problems and every-day errors which generate no bad outcomes.

2.4 Methods

There are numerous methods available to investigate maintenance error. These include:

- Round-table group discussions
- Paper-based tools
- PC based tools
- Proactive tools
- Self-reporting schemes

Maintenance round tables

Many companies use this method where a meeting is held every 3 months or so and incidents are discussed. Usually such meetings involve the Safety Manager, Quality Manager(s) and other Departmental Managers. They do not usually involve the individuals who have been involved in the incidents. This method is only successful if the individuals around the table have sufficient knowledge of what actually caused the problems under discussion, rather than merely what their 'symptoms' were. There is danger of such a method being just a 'fire-fighting' exercise.

Paper-based tools

The best known method in this category is probably Boeing's Maintenance Error Decision Aid (MEDA), although MEDA is more than just a paper-based tool - it is a complete and wide-ranging process with a paper-based investigation tool at its core. In the USA, about 33% of airlines use MEDA, about 33% are thinking about it, and about 33% have decided not to use it due to concern about vulnerability to regulatory action and litigation particular to the USA. Many Canadian airlines are using the MEDA process, as are several UK airlines. It is understood that Boeing offer free MEDA training to any of their customers, and are prepared to provide training for non-Boeing customers as long as their costs are covered. Contact Boeing for further details (see contacts sheet attached to this handbook).

Many airlines adopt the MEDA approach but badge it with a different name (eg. MEI, MERIT, MESA, etc). Boeing has no objection to this, the approach being free for anyone to use and name as they wish, although Boeing would recommend that the MEDA principles, approach and training not be changed radically.

The Aircraft Dispatch and Maintenance Safety (ADAMS) consortium has also produced a paper-based tool, similar to the MEDA form but much expanded. Further details concerning this tool can be obtained from any of the ADAMS consortium members (see Part 2 of this Handbook), or from *www.tcd.ie*

PC-based tools

The majority of these tools are computerised versions of the MEDA form, some with inbuilt data analysis capabilities. These include:

- Tool for Error Analysis in Maintenance (TEAM), developed by Galaxy Scientific, customised for each airline (contact Galaxy for further details)
- BASIS Maintenance Error Investigation (BASIS MEI), developed by BA, a module of the well-known BASIS tool. Contact BA for further details.

- Aurora Mishap Management System (AMMS), developed by ex-MEDA and ex-US Air Force personnel, for use in the transportation industries (ie. not maintenance specific).
- MEDA/SEDA tool developed by BFGoodrich. (Users may need to customise the tool slightly to suit their own operations.) Available free of charge from BFGoodrich or via the UKCAA.
- UKCAA MEMS FMS (Maintenance Error Management System Free MEDA Software) tool - a customised generic version of the BFGoodrich software. Available free of charge from the UKCAA.

Note: It should be stressed that a PC-based tool, on its own, is not enough; what is important is the methodology used, and the internal company support for the methodology used (eg. senior management support, a just disciplinary policy, and making resources available to investigate incidents). However, a PC-based analysis tool enables MEDA to be proactive in the sense of identifying latent problems and acting upon them before they result in an incident.

Proactive tools
Managing Engineering Safety Health (MESH) was developed by Professor James Reason in conjunction with BA, and involved engineers inputting data into a computer at regular intervals, as opposed to after an incident. This has been used by BA and SIA.

Self reporting
These systems are somewhat different to the above tools because they are generally external to the company. The Aviation Safety Reporting System (ASRS) (*asrs.arc.nasa.gov*) in the USA is the largest, with the Confidential Human Factors Incident Reporting Programme (CHIRP) (*chirp.dircon.co.uk*) in the UK and a few others around the world. These provide a vehicle for voluntary reporting, with reportee details deleted after all the details are obtained in order to protect subscribers. These are not Maintenance Error Management Systems in the sense that they are described in this handbook, but nevertheless provide a valuable mechanism for feeding back information on problem areas to the company management and others.

Other MEMS tools
The UK has a Mandatory Occurrence Reporting Scheme (MORS), as do many other countries. Whilst such schemes tend not to incorporate all the elements of a MEMS tool, nevertheless they work on similar principles, albeit usually only with more significant incidents.
The USA has the Air Carrier Voluntary Disclosure Programme (VDP), which provides some degree of immunity to organisations if they are seen to be acting to prevent problems. Also, the USA has an Aviation Safety Action Programme (ASAP), which is a round-table approach involving the FAA, the airline and the Unions.

2.5 Use of the data

There is little point in incident reporting, investigation, data storage and analysis unless the information is acted upon. Analysis and action tend to be grouped into two categories: (i) that involving each individual incident and (ii) that which looks at patterns of incidents and contributing factors. Both are important, but the latter is of greater importance in that can help an organisation appreciate where its weaknesses lie, and which incidents are due to systemic problems and which are only ‘one-offs’. The latter can also provide trend information which, if interpreted correctly, can show whether measures such as the introduction of a human factors / error management programme, are being effective. Note: care should be taken when looking at

data in this way, since there are many factors which can affect the data and obscure the real trends.

2.6 Data Sharing

One step further is to exchange data between organisations, such that one organisation can learn from anothers' problems and solutions, and global problems, not specific to individual organisations, can be better identified. However, there are many issues associated with data exchange, especially the need to ensure confidentiality of personal details, and organisations are advised to investigate the potential pitfalls before committing to data exchange. The Global Aviation Information Network (GAIN) programme is a good source of further information concerning data exchange issues.

At the recent GAIN conference in June 2000, some tools were presented which claim to assist organisations share data whilst protecting confidentiality and security. Two of these tools are called Xwave and Avshare. Further information on Xwave can be obtained from *www.tc.gc.caa/tdc/index.htm.* Further information on Avshare can be obtained from *sales@avsoft.co.uk*. The ATA are also working towards the goal of data sharing. Further information on this will be added when available.

Recommended reading

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2. AWN71
3. Marx David A.. Learning from our Mistakes: A Review of Maintenance Error Investigation and Analysis Systems". 1998 *hfskyway.faa.gov*
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10. ASRS Callback.
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Further Reading

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3. Training for Error Management, Human Factors and Maintenance Resource Management (MRM)

3.1 Introduction

ICAO recognise the need for human factors training and the limitations with some of the existing training programmes. The ICAO Human Factors Manual states: *"Although human failure is the predominant factor contributing to aviation accidents and incidents, it has never been clear what aspects of human capabilities and limitations should - or could - be addressed by training. On the other hand, it has been equally clear for some years that Human Factors education and training within the aviation system could be improved"*. The Manual goes on to offer guidelines for such improvements.

The ICAO requirements associated with Human Factors training are listed in Part 3 of this Handbook, Chapter 3.

The guidance material in this Handbook was taken from several sources, including the ICAO Human Factors Training Manual. The JAA Maintenance Human Factors Working Group, Training sub-group are in the process of drawing up guidelines, and these will be added to this Handbook when available.

Human Factors training can take several forms, including:

- training to meet the JAR66-9 knowledge requirements
- training to meet other regulatory requirements or ICAO recommendations
- training on the company human factors programme
- training on fundamental human factors principles
- Maintenance Resource Management Training (MRM)
- Management training, incorporating aspects of human factors
- Health and Safety at work training, incorporating aspects of human factors

Note: The terms "Human Factors" , "Maintenance Error Management" and "MRM" are sometimes used interchangeably in the context of training, and other times used to refer to slightly different concepts, depending on which documents you read, and how long ago that document was written. The term "MRM" was originally used as a parallel to "CRM" (Crew Resource Management (training)) but has evolved somewhat over the years as it has been appreciated that the CRM concepts could not all be related directly to the maintenance engineering context. The MRM Handbook outlines these differences very well.

Human factors training appropriate for each organisation and each group of personnel are likely to differ from place to place and group to group. However, there will be certain core elements which will be applicable to most situations, or which will be included due to regulatory requirements. A list of the ICAO modules can be found in Appendix C). Care should be taken to distinguish between knowledge requirements and training requirements, and initial and recurrent training.

This Chapter concentrates upon Human Factors training in the context of an organisation, where the training should cover the broader spectrum of Human Factors issues as they affect the

Company, and the safety of those aircraft maintained by the Company. It does not specifically address JAR66-9 human factors knowledge requirements, although a copy of the syllabus is given in Appendix D and a list of Organisations offering aeronautical engineering courses, of which part will cover human factors, is given in Appendix E.

This Chapter will endeavour to give guidelines as to what might be appropriate in terms of Human Factors training, leaving the organisation to tailor this to its own needs.

3.2 General principles

The following guidelines should be considered:

1. The course should comprise a mix of personnel, job roles and seniority to help the attendees gain an overall picture of HF problems and their impact across the company.
2. The course should ideally be presented by an employee of the company or, if this is not possible, by individuals with engineering and maintenance organisation experience, or at least a familiarity with civil aviation maintenance.
3. The course should be specific to maintenance engineering, not a generic human factors or CRM course.
4. The CEO, a Director, General Manager or other very senior person within the company should open and/or close each course (or at least attend for part of the time), to emphasise the company's commitment to the HF programme.
5. Real company examples of the topics, concepts and theories contained in the course should be provided to, or elicited from, the trainees to help them transfer the information they obtain from the course back into the workplace.
6. A 'just' culture is as important in the classroom as it is in the workplace. Trainees should feel able to voice their opinions without fear of reprisal.
7. Undertake to feed back answers to any issues raised following training, formally if possible.

Training should create an awareness of the human aspect of aircraft maintenance and help to develop safeguards to lessen the human causal factors in maintenance error.

3.3 MRM principles

The following information has been adapted from the "Maintenance Resource Management Handbook" available on *hfskyway*.

1. Maintenance Resource Management is a general process for improving communication, effectiveness, and safety in aviation maintenance operations. Effectiveness is measured through the reduction of maintenance errors, and improved individual and unit coordination and performance.
2. MRM is also used to change the "safety culture" of an organization by establishing a pervasive, positive attitude toward safety. Such attitudes, if positively reinforced, can lead to changed behaviours and better performance.
3. Safety is typically measured by occupational injuries, ground damage incidents, reliability, and airworthiness. MRM improves safety by increasing the coordination and exchange of information between team members (intra-team), and between maintenance teams (inter-team).
4. The details of MRM programs vary from organization to organization. All MRM programs link and integrate traditional human factors topics, such as equipment design, human physiology, workload, and workplace safety. Likewise, the goal of any MRM program is to improve work performance and safety. MRM programs do this by reducing maintenance

errors through improved coordination, communication, and increased awareness.

5. A prerequisite for implementing successful MRM is management's will to do so. As with any program intended to be diffused throughout an organization, MRM must have the positive, explicit, and demonstrated support of senior management.

Maintenance Resource Management represents the next logical step in the evolution of team-based safety behaviors. Just as technical skills alone were not enough for flight crews to manage complex systems, technicians are being taught skills that enable them to work more safely in a complex system. MRM teaches more than just team skills; it teaches and reinforces an organisational philosophy in which all members of the organisation are oriented toward error-free performance. This is accomplished by teaching managers and technicians:

- how the effects of their actions ripple throughout their organisations,
- how to utilise all of their available resources safely and effective, and
- how to propagate a culture of safety in their respective organisations through specific, individual actions.

The overall goal of MRM is to integrate maintenance personnel's technical skills with interpersonal skills and basic human factors knowledge in order to improve communication, effectiveness and safety in aircraft maintenance operations.

3.4 Human Factors Course or Product Providers

There are many consultants and companies which provide human factors training for personnel involved in maintenance engineering. There are also several training products available, including computer based training (CBT) products, course outlines which organisations are encouraged to adapt, and training videos. A list is given below of some of these providers and products. This list should not necessarily be judged as a recommendation, nor as a comprehensive directory. It should be up to each organisation to decide whether they need a training product or course/workshop, and to make their own judgement as to what best suits their needs. Some additional information has been provided in Part 2 of this Handbook to help with that choice.

Some Training courses, videos and products:

- Canadian Aviation Maintenance Council (CAMC) products (CBT and IBT)(see Appendix 2B-5)
- Human Factors Safety Training for the Aircraft Maintenance Industry (STAMINA) (Ireland) (see Appendix 2B-13)
- Aircraft Maintenance Team Training (AMTT) (CBT)(see Appendix 2B-1)
- Maintenance Human Factors Awareness Training for Managers (USA)(see Appendix 2B-8)
- Human Factors in Maintenance Workshops (Canada) (see Appendix 2B-4)
- The IFA video "Every day" (see Appendix 2B-11)
- The IFA video set and training package "Engineering solutions to human problems" (see Appendix 2B-11)
- Video series from the Maintenance and Ramp Safety Society (MARSS) (see Appendix 2B-4)

Some human factors training providers:

- System Safety Services (Canada) (see Appendix 2B-3)
- Grey Owl Aviation Consultants (Canada) (see Appendix 2B-2)
- David Marx Consulting (USA) (see Appendix 2B-9)

- Boeing Flight Safety (USA) (see Appendix 2B-8)
- Latta Aviation Consultants (Canada) (see Appendix 2B-6)
- Galaxy Scientific (2B-14)

Recommended Reading

1. People, Practices and Procedures in Aviation Engineering and Maintenance: A practical guide to Human Factors in the Workplace" produced by the UK Human Factors Combined Action Group (UKHFCAG). 1999. *www.raes.org.uk*
2. ATA Specification 113 for Maintenance Human Factors Program Guidelines. *http://www.air-transport.org/public/publications/57.asp*
3. Maintenance Resource Management Handbook. B Sian, M Robertson, J Watson. *Hfskyway.faa.gov*
4. ADAMS. Human-Centred Management Guide for Aircraft Maintenance: Aircraft Dispatch and Maintenance Safety (ADAMS). ADAMS Consortium. (2000)
5. ICAO. Human Factors Training Manual. Doc 9683-AN/950. 1998.
6. *www.camc.ca*

Further Reading

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5. Line-oriented human factors training: MRM III. B Sian, M Robertson. Chapter 3, FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase VIII, Progress Report, 1998. *hfskyway.faa.gov*
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7. MRM: it can't be CRM re-packaged. R Lofaro (FAA:AAR-433) Proceedings of the Eleventh Meeting on Human Factors Issues in Aircraft Maintenance and Inspection, 1997
8. Maintenance Resource Management Update at Continental. J Stelly (Director, Systems and Training, Continental Airlines) Proceedings of the Tenth Meeting on Human Factors Issues in Aircraft Maintenance and Inspection, 1996
9. The Effects of Crew Resource Management (CRM) Training in Maintenance: An Early Demonstration of Training Effects on Attitudes and Performance. Chapter 7. FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase II Progress Report, 1993; Chapter 6, FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase III vol II Progress Report, 1993. *hfskyway.faa.gov*
10. Crew coordination concepts for maintenance teams. J Stelly, Jr. (Continental Airlines, Inc.), J Taylor (University of Southern California) Proceedings of the Seventh Meeting on Human Factors Issues in Aircraft Maintenance and Inspection, 1992
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