

# CREW RESOURCE MANAGEMENT

*A PAPER BY THE CRM STANDING GROUP OF  
THE ROYAL AERONAUTICAL SOCIETY*

## **INTRODUCTION**

1. Crew Resource Management (CRM) has now been in existence for over 2 decades but confusion still exists within the aviation industry and elsewhere as to precisely what the term implies. Some people feel that CRM is 'psychobabble' invented by the ignorant and strange, who have schemed to turn ordinarily good chaps, with tons of airmanship and leadership, into uncertain freaks with cloned personalities. This view has been reinforced by various less than adequate attempts to evaluate the outcome of CRM training. Meanwhile, at the opposite pole, others believe that CRM is a panacea for all that is wrong in aviation and will prevent flying accidents for evermore. Between these extremes lie a wide range of views and activities embracing almost the entire spectrum of human factors in aviation.

2. Despite the considerable amount of effort already devoted to CRM training, aircraft accidents attributable to human factors continue to occur. This trend, together with the lack of a universally accepted view of the route ahead, suggests that in recent years the CRM programme has begun to lose its way. The purpose of this paper, which is addressed to all those involved in the safe and efficient operation of aircraft, is therefore to provide a firm basis for the continuing development of CRM by redefining its constituent elements and summarising best practice in each area as it exists within the aviation industry today.

## **AIM**

3. The aim of this paper is to re-establish the role and credibility of CRM in order to improve operational efficiency and enhance flight safety within the aviation industry.

## **BACKGROUND**

4. CRM was developed as a response to new insights into the causes of aircraft accidents which followed from the introduction of flight recorders and cockpit voice recorders into modern jet aircraft. Information gathered from these devices has suggested that many accidents result not from a technical malfunction of the aircraft or its systems, nor from a failure of aircraft handling skills or a lack of technical knowledge on the part of the crew; it appears instead that they are caused by the inability of crews to respond appropriately to the situation in which they find themselves. For example, inadequate communications between crew members and other parties lead in turn to a loss of situational awareness, a

breakdown in teamwork in the aircraft, and ultimately to a bad decision or series of decisions which result in a serious incident or a fatal accident.

5. The widespread introduction of the dynamic flight simulator as a training aid allowed various new theories about the causes of aircraft accidents to be studied under experimental conditions. On the basis of these results, and in an attempt to remedy the apparent deficiency in crew skills, additional training in flight deck management techniques was introduced by some airlines. Following a period of experimentation and development, the techniques embraced by the new training became known collectively as CRM. The importance of the CRM concept and the utility of the training in promoting safer and more efficient aircraft operations have now been recognised world-wide. For various reasons, however, progress in CRM development appears to have waned in recent years, and the focus of flight safety has shifted away from human factors and towards systematic error prevention and management. Fresh impetus is needed, therefore, if earlier gains brought about by the introduction of CRM are not to be negated by a loss of momentum, particularly as CRM can itself be regarded as a highly effective error prevention and management tool.

### **CRM DEFINED**

6. CRM encompasses a wide range of knowledge, skills and attitudes including communications, situational awareness, problem solving, decision making, and teamwork; together with all the attendant sub-disciplines which each of these areas entails. The elements which comprise CRM are not new but have been recognised in one form or another since aviation began, usually under more general headings such as 'Airmanship', 'Captaincy', 'Crew Co-operation', etc. In the past, however, these terms have not been defined, structured or articulated in a formal way, and CRM can be seen as an attempt to remedy this deficiency. CRM can therefore be defined as a management system which makes optimum use of all available resources - equipment, procedures and people - to promote safety and enhance the efficiency of flight operations.

7. CRM is concerned not so much with the technical knowledge and skills required to fly and operate an aircraft but rather with the cognitive and interpersonal skills needed to manage the flight within an organised aviation system. In this context, cognitive skills are defined as the mental processes used for gaining and maintaining situational awareness, for solving problems and for taking decisions. Interpersonal skills are regarded as communications and a range of behavioural activities associated with teamwork. In aviation, as in other walks of life, these skill areas often overlap with each other, and they also overlap with the technical skills required in an aviation context. Furthermore, they are not confined to multi-crew aircraft, but also relate to single pilot operations, which invariably need to interface with other aircraft and with various ground support agencies in order to complete their missions successfully.

### **COGNITIVE SKILLS**

8. **Situational Awareness** Situational awareness involves conscious recognition of all the factors and conditions - operational, technical and human - which affect the safe operation of an aircraft. In order to establish situational awareness, human beings take in information through the 5 senses - touch, hearing, smell, sight and taste - and also sub-consciously or intuitively. This information is then transformed by the brain into a mental model of the situation, a process known as perception. The perceptive process depends not merely on current information for its evaluation of the situation but also takes account of past

experience and sensations. Perception is therefore a product not only of immediate sensations but also of cultural and social influences acquired through a life-time of experiences. Accordingly, because of the different factors which have shaped their lives, individuals interpret situations differently. Furthermore, they can also be unduly influenced by false information derived from the senses, such as illusions. Because of these factors, a high degree of situational awareness can be said to be achieved only when an individual's perception of events approaches the reality of the situation.

9. For the pilot of an aircraft, much of the information from which situational awareness is derived comes from the flight instruments and the navigational equipment on board, so the process of constructing an accurate mental model of the position of the aircraft in space, its condition, and the condition of the crew, is subject to a number of degrading influences such as inattention, distraction, under-arousal, stress, boredom, fatigue, etc, etc. In these circumstances, confirming the accuracy of mental models with other crew members by sharing information and perceptions about the situation, and by stating intentions, becomes of paramount importance in the safe and effective management of the flight. Furthermore, sharing knowledge and information not only helps to avoid the more obvious incidents and accidents arising from loss of situational awareness, such as controlled flight into terrain, but also lays a firm foundation for high quality decisions regarding the overall management of the flight.

10. **Planning and Decision Making** A central aim of CRM is to ensure that high quality decisions are taken across the whole spectrum of flight operations. In this context, thorough pre-flight planning will not only provide a yardstick against which in-flight decisions can be made but will also allow all members of the crew to manage successfully their own specific areas of responsibility. Understanding the plan also allows individual crew members to contribute in the most effective way to decisions made in flight. It is important, therefore, as the flight progresses, that the Captain updates the crew at regular intervals on any changes to the original plan, so that individual crew members can maintain good situational awareness. This is particularly important during abnormal operations or in an emergency situation, where conditions affecting the progress of the flight and the safety of the aircraft are likely to change rapidly. In these circumstances, regular updates on the status of the flight allow each individual crew member to be sufficiently aware of the situation and needs of the moment to contribute in the most effective way to the decision-making process.

11. Allowing subordinate crew members to participate in the decision-making process does not mean that all decisions have to be made by committee. The degree of participation or otherwise from subordinate crew members depends to some extent on the type of behaviour which underpins the decision:

11.1 Skill-based behaviours rely to a large extent on prior learning and any associated decisions are made mainly subconsciously. In this situation, other crew members provide a passive monitoring role, although this may call for assertive intervention if the level of skill being displayed by the decision-maker falls below a safe standard (for example, if it is perceived by a non-flying crew member that the aircraft may be inadvertently descending in cloud towards high ground). Rule-based behaviours rely on previously-considered courses of action such as Standard Instrument Departures (SIDs), Standard Operational Procedures (SOPs), Flight Manuals, etc, and the associated decisions are made partly in the subconscious, where previous experience and training come into play, and also in the conscious mind, where previous learning is compared with the realities of the current situation.

In these circumstances the participation of another crew member may be required to provide verification of the situation and validation of the course of action being proposed by the decision maker. Finally, knowledge-based behaviour is utilised in a situation which has not previously been encountered. In these circumstances, the crew is called upon to make a decision based upon a rational appraisal of the facts, so there may be considerable scope for the involvement of other crew members and - if time and circumstances permit - even outside agencies such as ATC or Technical Control.

11.2. The degree of participation in the decision-making process also depends to a considerable extent on the organisational culture, as well as current social norms. These factors include the aircraft commanders' perception of his or her role and authority, and the way in which this perception is shared by other crew members and the various supporting agencies. In today's climate, commanders who manage the flight in an open and affiliative style, and who state their intentions from time to time in the course of the flight, are more likely to secure the co-operation and participation of other crew members than those who are overbearing and autocratic. Command style, however, is normally based on a perception of what the company or organisation expects from each individual crew member, and effective CRM will therefore flourish only where an organisational culture exists which empowers and encourages subordinate crew members to assist the Captain by participating appropriately in the decision-making process whenever the need for them to do so arises.

## **INTERPERSONAL SKILLS**

12. **Communications** From the foregoing discussion on cognitive skills, it is evident that effective communication between crew members is an essential prerequisite for good CRM. Research has shown that in addition to its most widely perceived function of transferring information, the communication process in an aircraft fulfils several other important functions as well. It not only helps the crew to develop a shared mental model of the problems which need to be resolved in the course of the flight, thereby enhancing situational awareness, but it also allows problem solving to be shared amongst crew members by enabling individual crew members to contribute appropriately and effectively to the decision-making process. Most importantly, it establishes the interpersonal climate between crew members and is therefore a key element in setting the tone for the management of the flight.

13. The communication process invariably takes place in a social and organisational context and it is therefore profoundly influenced by company culture. Its effectiveness also depends on the experience level of the pilot or crew members involved in the transaction and their perception of their roles and position in the chain of command. The effectiveness of the communication process also depends on the nature of the task and operational context in which the flight is taking place - eg. the phase of flight, and whether it is being conducted under normal, non-normal or emergency conditions. In addition, it is affected by the mode of speech employed and the linguistic context in which the transaction takes place. In this context, individual styles, body language, grammatical styles and speech act patterns all have their part to play. Because of these complexities, crew members need to be aware of and sensitive to the nuances of effective communication. They also need to understand and avoid where possible those elements which constitute a barrier to effective communication.

14. **Teamwork** Successful teamwork is achieved when the output of the team is greater than that which could be developed by the sum of the efforts of the individual crew members acting in isolation - a process known as synergism. Synergism is produced by a process of interaction between crew members, whereby each individual is empowered and encouraged to contribute in the most effective way to the overall task of the team. Interaction is unlikely to occur, however, unless all individual members of the team fully understand their role within the group and how this role may vary depending on the circumstances under which decisions are being made and action taken. Consequently, good communications within the group, a high degree of situational awareness and a comprehensive understanding of the decision-making process by all members of the group are all prerequisites for the creation of synergy and the effective performance of the team as a whole. For operational reasons, many crew members form part of a new team on every flight, so it is important that the overall organisation culture encourages and fosters a climate in which good teamwork can flourish. It is also evident that a healthy organisational culture, which actively promotes CRM, will also foster good teamwork, since CRM and teamwork are inextricably intertwined in the realm of effective flight management techniques.

### **EMOTIONAL CLIMATE AND STRESS**

15. **Emotional Climate**. The term 'emotional climate' refers to the way that people in the team feel about themselves and each other during flight operations. Research indicates that factors which create a positive tone individually and collectively on the flight deck and among the wider operating team enhance the effectiveness of the cognitive and interpersonal skills displayed by crew members. Factors that have been shown to affect the emotional climate in which the team operates include perceptions of safety, clarity of job and task expectations, supportive communication, participation and involvement, recognition for contribution and freedom of expression. While the climate or tone of the operation depends to a large extent on the attitude and conduct of the Captain, every crew member should, nevertheless, be aware of the significance of a good working climate, and strive to put into practice those behaviours that are conducive to it.

16. **Stress**. A factor which can quickly undermine the emotional climate in which the crew is operating is stress - defined as a state of highly unpleasant emotional arousal associated variously with overload, fear, anxiety, anger and hostility - all of which threaten both individual performance and teamwork. Stress often arises as a result of a perceived gap between the demands of a situation and an individual's ability to cope with these demands. As stress involves the processes of perception and evaluation, it impinges directly on the cognitive and interpersonal skills which form the basis of good CRM. Both arousal and alertness are necessary to enable each individual to achieve optimum performance in CRM-related skills, but too much or too little arousal will have a significantly adverse impact on the ability of the crew to function effectively as a team. It is therefore important for crew members not only to be aware of the symptoms of stress in themselves and others, but also to understand the effects which stress can have on CRM, and to mitigate these effects where possible by taking measures to counter them.

17. **Managing Stress**. In high pressure situations, stress can be relieved by establishing priorities and by delegating tasks to other members of the crew, but this technique can be successfully implemented only if an organisational culture has been established in the first instance which empowers subordinates by training them in the cognitive and interpersonal skills which will enable them to take on additional responsibility when the circumstances call for it. In a low pressure situation, where fatigue, boredom and over-familiarity with the

task are the greatest hazards, careful attention to environmental conditions such as heat, humidity noise, vibration and lighting can help to maintain alertness. Concern of individual crew members for their own physical well-being by keeping fit and maintaining a healthy life-style, in so far as the demands of the job allow, will also help to ensure that they are best able to contribute to the team effort when the need arises.

### **CRM TRAINING**

18. To maximise their effectiveness in the aircraft, crew members not only need to acquire a sound grasp of the technical knowledge and skills necessary for the fulfilment of their particular role in the aircraft, but they also need to understand and develop the cognitive and interpersonal skills which are a prerequisite for good CRM. The nature of these latter skills, however, is such that they cannot readily be taught by the didactic training methods normally used to impart technical knowledge about the aircraft and its systems - methods sometimes referred to as 'chalk and talk'. Cognitive and interpersonal skills - CRM skills - are mostly concerned with understanding and interpreting behaviour, particularly behaviour which occurs in a group context, so they are more appropriately developed through a process known as experiential learning. Successful experiential learning occurs when an individual reflects on his or her past behaviour in a given organisational situation and gains sufficient insight to form a rational basis for behaving in a more effective way when faced with similar circumstances in the future. Consequently, CRM training usually takes place in groups and is often assisted by a trained facilitator who is equipped with the relevant knowledge, skills and techniques to foster the learning process. The performance standards required by instructors in CRM have recently been defined by an accreditation focus group under the auspices of the Royal Aeronautical Society. For both historical and practical reasons, CRM skills have up to now been taught separately from technical knowledge and skills, but the considerable area of overlap between the two disciplines suggests that the training would be more effective if it was integrated from the earliest stages of the aircrew training regime.

### **BEHAVIOURAL MARKERS**

19. Knowledge and experience about CRM built up in recent years by the use of facilitative training techniques has led to attempts to define optimum performance by the use of behavioural markers. Although these attempts are still in their infancy, a successful outcome would not only help to define more clearly the cognitive and interpersonal skills required for good CRM but also allow for a standard approach the current problem of assessment, feedback and further training of individual crew members.

### **ASSESSMENT OF CRM SKILLS**

20. The subject of CRM assessment is an emotive one. Operators want it, the JAA has mandated it, but many pilot bodies are opposed to the testing of CRM. The debate does highlight, however, that an element of trust is essential if CRM is to be adopted enthusiastically by the entire aviation community. Furthermore, that trust will be difficult to establish if those under scrutiny perceive that the assessor is exhibiting the very trends that are being criticised.

21. Until all instructors have a common concept of CRM, and are able to act as a role model for the standards they are attempting to discuss, acceptance is likely to be patchy. So, at present, any judgement on CRM skills should be confined to encouraging pilots to recognise that they have progress to make, and that they need to undergo further training.

However, in order to train crews appropriately, and to ensure they are fully competent to operate aircraft safely and efficiently, then some form of assessment of CRM knowledge and skills will need to be introduced.

22. The successful conduct of a flight depends not only on a high standard of technical knowledge and skills but also on good CRM skills. Technical knowledge and skills are already assessed using long-established methods which have the full support of crew members and the regulatory authorities, and it follows that a satisfactory method of assessing CRM skills must also be devised and integrated into the flight regulatory system if accidents caused by human factors are to be significantly reduced. In the transitional phase, however, the following safeguards will need to be introduced until well-defined CRM competencies and methods of assessment have been satisfactorily established and agreed by crews, airline management, insurance agencies and regulators:

22.1 Competency standards should be agreed by crews, operators and regulators.

22.2 Standards should be clear, published, and reflect best practise.

22.3 Competency standards should be achievable by the vast majority of licence holders.

22.4 Where standards are not attained the subject should be provided with additional training and guidance.

22.5 Trainers should be qualified to standards agreed by all parties and required to demonstrate these qualities to the Regulatory Authority at regular intervals.

22.6 Where there is a disagreement as to the level of competency required, pilots should have access to a second opinion. This opinion should be independent of the employing company, and agreed by both parties.

## **CONCLUSION**

23. The concepts which underpin CRM are not new or gimmicky; rather they are an attempt to distil old axioms into a more coherent and cogent management style across the flight regime. Safe and efficient flight operations depend for their success not merely on the acquisition of sound technical knowledge and skills but also on the mastery by aircrew of the cognitive and interpersonal skills which form the basis of good CRM. Cognitive skills not only allow for the development and maintenance of good situational awareness but also underpin high quality problem solving and decision making techniques. In addition, interpersonal skills, which depend for their effectiveness on good communications, encourage the creation of synergy and the development of successful teamwork. Both cognitive and interpersonal skills are enhanced by a good emotional climate amongst the crew, but they are also easily degraded by stress, so management of the emotional climate and stress becomes an integral and important element of good CRM.

24. Currently, technical training and training in CRM skills is carried out separately, but in view of the crucial part which each aspect plays in the safe and efficient operation of aircraft, both types of training need to be integrated at the earliest opportunity. Moreover, CRM training would be considerably enhanced if a satisfactory and universally agreed set of behavioural standards could be developed. To ensure that the training is effective, CRM skills also need to be assessed in conjunction with the evaluation of technical knowledge

and skills, although certain safeguards will need to be put in place until a satisfactory method of assessing CRM skills has been devised and accepted on an industry-wide basis.

25. CRM is not, therefore, merely an abstract management concept; it embraces principles and skills which, if combined with a high degree of technical knowledge and skill, will enable the crew to make best use of all available resources to achieve optimum efficiency in the conduct of operations while at the same time maximising the safety of the flight.

### **NEXT STEPS**

26. As a matter of urgency, the aviation industry should take the following steps:

26.1. Agree CRM competency standards.

26.2. Agree the CRM trainer and examiner competency standards.

26.3. Develop training programmes to ensure instructor standards.

26.4. Develop training programmes to address CRM competency standards.

26.5. Develop and agree appropriate CRM assessment methodologies.

26.6. Ensure corporate cultures support the implementation of the above.

26.7 Integrate or link training in technical knowledge and skills with training in CRM skills at the earliest possible stage in aviation training.

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**References:**