

Airmanship Training For Modern Aircrew

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SUMMARY

It is widely accepted within aviation circles that *airmanship* is key to modern aviation, yet there is considerable confusion as to what airmanship actually comprises. To some it is the “stick and rudder” skills associated with manual flying; to others it is the cognitive skills associated with decision-making and judgement. There is also a common belief that airmanship cannot formally be trained and is simply acquired through experience. None of these are completely true on their own. Instead, airmanship is a mixture of all of these attributes and much more besides.

This paper explores the concept of airmanship — its definition and basic components, and explains the importance of taking a holistic view of airmanship training as the necessary foundation for the creation of competent and professional aviators. It also presents a series of practical guidelines that can be applied in the training and assessment of airmanship skills.

Keywords: airmanship, training, cognitive skills, discipline

INTRODUCTION

The advent of modern technology in the cockpit has created a shift in the skills demanded of military aircrew, testing their ability to manage complex systems and to cope with unprecedented levels of information and data. Cognitive skills such as decision-making and situational awareness now take on an almost overriding significance and are fundamental to achieving a battle-winning edge. A step change in the conduct and content of military training is required to meet these new operational demands.

To meet this challenge, the UK Ministry of Defence has begun a 10 year programme to modernise military flying training across the UK’s Armed Services. The UK Military Flying Training System (UKMFTS) will provide a modern, holistic approach to aircrew training that will meet the future demands of the UK front line. As part of the changes wrought by the UKMFTS it is expected that considerable emphasis will be placed upon the employment of the latest teaching technologies and training platforms. However, perhaps the greatest change will be the increased emphasis that will be placed on developing *airmanship*, because it has been recognised to be the key element in producing outstanding aircrew performance.

Although the importance of airmanship has long been undisputed, there remains considerable confusion as to what it actually is and how it is best taught. This paper examines the inherent qualities associated with effective airmanship, identifies the key knowledge, skill and attitude requirements and proposes a number of strategies for the training and assessment of airmanship skills.

DEFINITIONS OF AIRMANSHIP

Airmanship is a term that has relevance throughout aviation from commercial and general aviation through to the military domain. It applies equally to pilots and non-pilot aircrews (e.g. navigators) and is as relevant on the ground as it is in the air. Airmanship is accepted as being extremely important, yet it is a concept

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that has been difficult to define — it is something that all aircrew understand but seem unable to put into words.

To some, airmanship simply means developing expert flying skills; to others it means exercising good judgement. To some, it is a collective term used to summarise all the skills and knowledge required to operate an aircraft; to others it simply represents a professional attitude or code of conduct.

Many researchers have attempted to define airmanship but as yet there is no universally accepted definition. Those offered in the literature include:

“Airmanship is effective decision making to support a sequence of actions.”	Training Development Support Unit 2000 [1]
“Airmanship is the care and attitude that you bring to the conduct of your flying. It encompasses consideration for your passengers, care of your aircraft, courtesy to other airspace and airfield users and the self discipline to prepare and conduct your flights in the most professional manner possible. It is not just flying skill that distinguishes a good pilot; it is his or her standard of airmanship.”	The Aviation Theory Centre 2001
“Airmanship is a personal and situational management state required to allow a human being to enter and exit, in safety, an environment which they were not naturally designed to inhabit.”	Hayes 2002 [2]
“Airmanship is the consistent use of good judgement and well developed skills to accomplish flight objectives. This consistency is founded on a cornerstone of uncompromising flight discipline and developed through systematic skill acquisition and proficiency. A high state of situational awareness completes the airmanship picture and is obtained through knowledge of one’s self, aircraft, team, environment, and risk.”	Kern 1996 [3]

From the literature, it is difficult to establish whether airmanship is a process, a state, a skill or an outcome. Whether it means having expert flying skills, sound judgement or good situational awareness; or whether it simply means having the “right attitude”.

The confusion stems from the fact that airmanship is *all of these things*. Airmanship is a multi-dimensional concept that involves acquiring and exercising both cognitive and physical skills in consonance. Moreover, it is about having the self-awareness and motivation to improve skills that may be lacking, and is a personal state or mind-set that compels aircrew to approach each flight with discipline and an appropriate attitude balancing safety against mission objectives.

Airmanship is also about achieving a balance. An airman who exercises good judgement but lacks the dexterity of control needed to operate an aircraft safely will not excel in airmanship. Similarly, an expert flyer (or operator) will fall short if he adopts a risk-taking attitude.

In essence, airmanship is about exercising judgement, discipline and having expert control of an aircraft and a situation.

Hence, airmanship can be defined as follows:

A personal state that enables aircrew to exercise sound judgement, display uncompromising flight discipline and demonstrate skilful control of an aircraft and a situation. It is maintained by continuous self-improvement and a desire to perform optimally at all times.

THE AIRMANSHIP APPROACH

Airmanship is more than simply having the requisite knowledge and skills; it is also about having an appropriate attitude, self-discipline and a desire to perform optimally at all times. Airmanship is an *approach* to aviation, which manifests itself in excellent performance.

The essence of the airmanship approach is captured in the model shown in Figure 1.

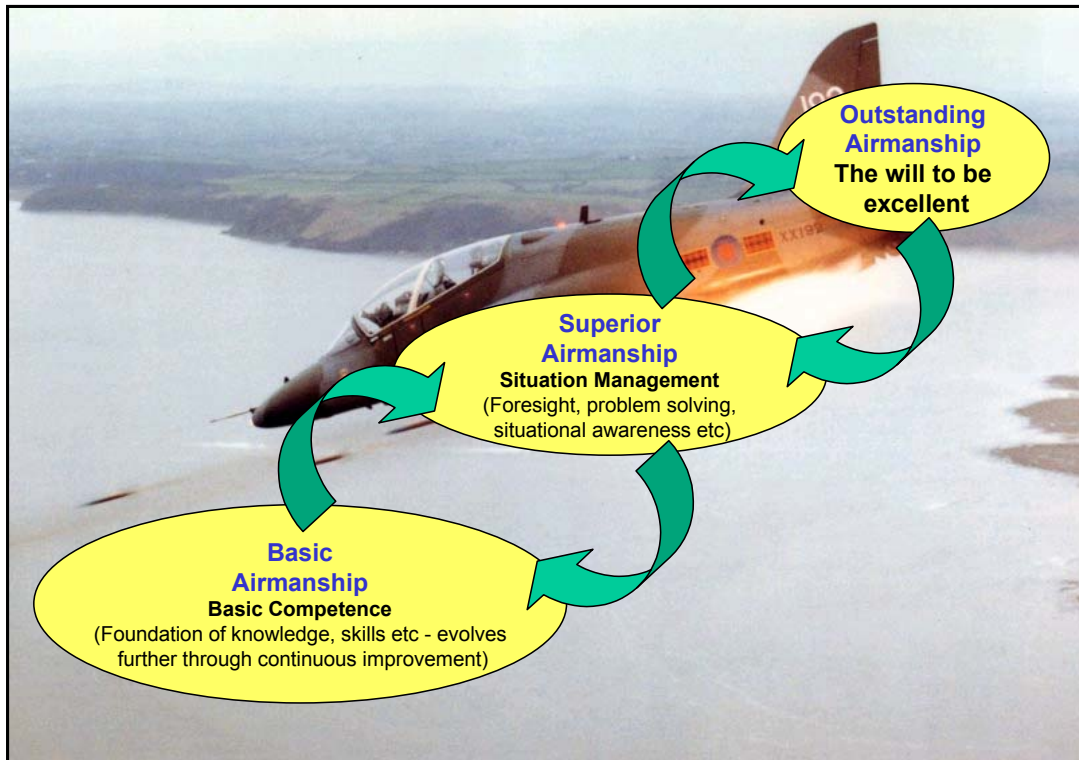


Figure 1: Levels of airmanship [4]

Aircrew operating at the basic level have the necessary knowledge, skills and attitudes and exhibit a textbook-based performance. With additional motivation, knowledge and experience, aircrew can move up to the superior level. Here, aircrew do more than simply follow standard operating procedures — they use foresight to anticipate problems and use higher-order skills such as situation assessment, judgement and problem solving to take a proactive rather than reactive approach to situation management. The demands of modern aviation necessitate that aircrew attain a superior level of airmanship.

At the highest level, is the desire to achieve excellence in all aspects of performance. Those operating at this level are dedicated to self-improvement and have a genuine desire to perform optimally at all times. Aircrew operating at this level seek airmanship excellence and this manifests itself in outstanding performance.

INDICATORS OF EFFECTIVE AIRMANSHIP

There are many examples of *ineffective* airmanship in the literature, but there are somewhat fewer examples of *effective* airmanship. However, those examples that can be found are extremely useful in making explicit the qualities associated with superior airmanship.

Take for example, the crew of a Delta Airlines flight from Houston to Dallas who demonstrated superior airmanship by landing the aircraft safely despite smashing into a flock of birds that destroyed one engine, damaged another and caused serious airframe damage.

An air traffic controller had asked the crew to participate in a 'no airspeed restriction' test being run by the FAA. The 727 accelerated, as requested, and at 6,000 feet struck a flock of snow geese. The crew instantly found the aircraft vibrating intensely and all power was lost in one of its three engines. The first officer's cockpit instruments had also failed, and the noise in the cockpit was deafening. The crew worked as a team to return the crippled aircraft to Houston. The first officer flew using the captain's instruments, while the captain, second officer and line check second officer analyzed the situation and performed the appropriate emergency procedures. They declared an emergency in the air with ATC and informed passengers of their situation. With the captain taking the controls on the aircraft's final approach, they landed safely with no injuries. [6]

The overriding theme running through examples of effective airmanship is the ability of aircrew to "control" a situation by using both their training and a certain amount of on-the-spot ingenuity. Specific qualities associated with effective airmanship include the following [4]:

- **Discipline** - abiding by procedures, despite the peculiarity of the situation.
- **Communication** - keeping others (e.g. ATC) informed of developments.
- **Teamwork** - working well together to resolve problems and maintain control.
- **Knowledge** - having a deep understanding of aircraft systems and operation.
- **Expertise** - transfer/retention of knowledge and skills.
- **Situation Assessment** - analysing and assessing unusual developments.
- **Judgement** - calling upon prior training and expertise to resolve unusual problems.
- **Decision Taking** - taking decisive action.
- **Resource Management** - allocating resources to ensure control of the larger situation is maintained whilst specific problems are being addressed.
- **Goal Prioritisation** - prioritising safety above personal concerns.

These attributes of airmanship emerge once something has gone badly wrong, however, good airmanship also means preventing things from going wrong in the first place, and so to the above list we can add:-

- **Situational Awareness** - maintaining awareness; being alert to any unforeseen situations arising.
- **Foresight** - anticipating potential hazards.
- **Planning** - working out courses of action to deal with potential hazards.

The above attributes suggest that there are explicit knowledge and skills that expert airmen employ to bring about positive outcomes to adverse situations. However, many of these skills and knowledge already form the basis of aircrew training programmes, particularly in the civil sector. So why is it then that some aircrew demonstrate superior airmanship when others do not?

The main discriminator is an airman's attitude towards aviation.

The Airman is a person who maintains a valid skill and knowledge currency such that when the unexpected does happen there is ability and composure enough to manage the situation into safety. He or she is a person with a sense of balance and intelligence enough to heed the lessons of the past, apply them in the present, and so ensure a future to be able to fly again, and again, and again.[2]

THE FOUNDATIONS OF AIRMANSHIP

Like intelligence, airmanship is often regarded as an innate quality — a natural ability that some aircrew possess and others do not. This perspective makes it extremely difficult to develop a working definition of the concept and fosters the belief that airmanship cannot be taught.

Whilst it is true that airmanship is a personal quality and individuals do vary in their natural ability for it, the assumption that the concept cannot be taught is false. Much is known about the underpinning elements that define airmanship and with training and encouragement pilots can be motivated to seek airmanship excellence.

Various studies have attempted to determine the essential ingredients of airmanship; perhaps the most comprehensive to date is a study conducted by Kern (1996) in which a model was developed that described the main ingredients of airmanship.

A more simplistic model is presented in Figure 2 that defines more specifically the foundations of airmanship.

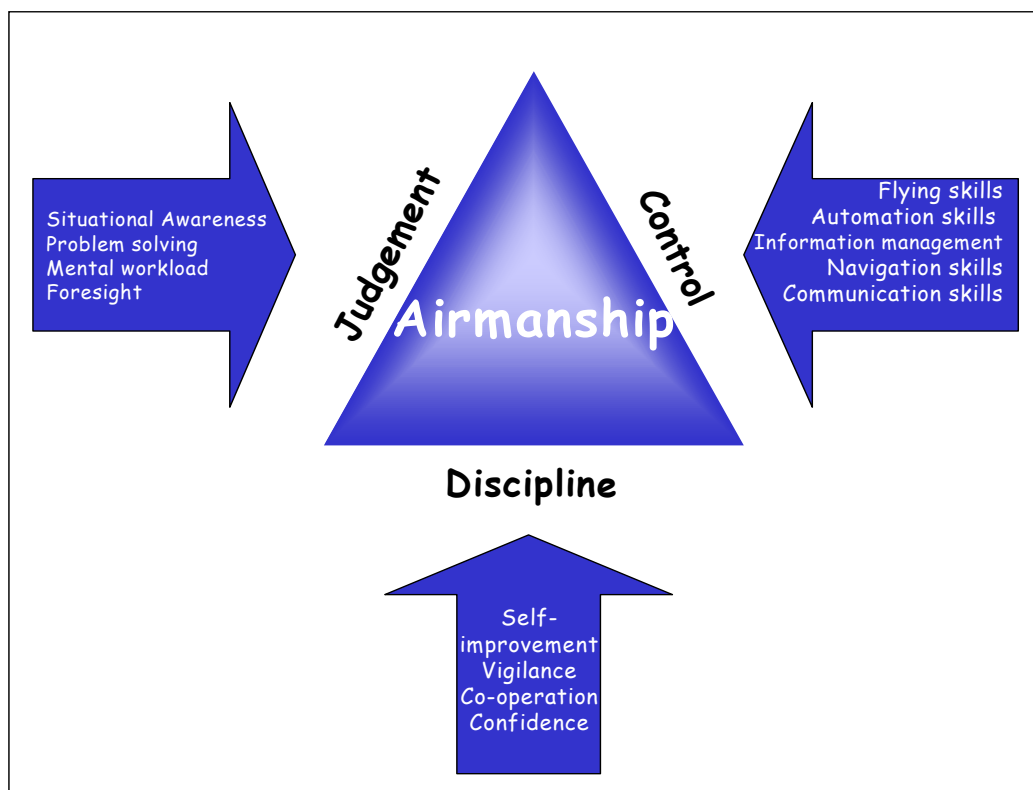


Figure 2 The elements of airmanship [5]

Judgement is used in the broadest sense to emphasise the need for aircrew to make conscious, intuitive, timely and well-founded decisions. *Control* is used as a reminder to maintain control of an aircraft whilst evaluating a situation and to execute a planned course of action with precision and accuracy — many good judgements are undone by failures in execution. *Discipline* is needed to detect potential errors at the earliest opportunity and to formulate considered judgements and execute controlled actions.

The foundations of airmanship are built on a specific set of knowledge, skills and attitudes (see Table 1). The elements listed in Table 1 should form the core syllabus of a training programme teaching the *foundations* of airmanship.

THE FOUNDATIONS OF AIRMANSHIP		
KNOWLEDGE	SKILLS	ATTITUDES
Knowledge of aircraft - Deep understanding of aircraft sub-systems, emergency procedures, cockpit automation, aircraft flight characteristics and operating limits.	Physical skills - Flying skills - Navigation skills - Instrument flying - Emergency handling / recovery - Combat survival	Hazardous attitudes - Understanding the five main hazardous attitudes, the antidotes and the impact on airmanship (see Table 2)
Knowledge of environment - Understanding the physical environment and the effects on aircraft control. - Understanding the regulatory environment. - Understanding the organisational environment and the challenges posed to airmanship.	Cockpit management skills - Avoiding the pitfalls of automation (over-reliance, complacency, bias) - Information management skills	Professionalism - Understanding the values and principles embodied in airmanship.
	Communication Skills - Vigilance in monitoring communications - Using appropriate communication (phraseology, clear, concise) - Active listening - Inquiry through communications	Self-improvement - Developing the motivation needed for life-long learning - Understanding the requirement for self-assessment in flight. - Developing the will to achieve performance excellence
Knowledge of risk - Understanding the risks to discipline, skill and proficiency, knowledge, SA, judgement, aircraft, self.	Cognitive skills - Understanding and maintaining situational awareness - Problem solving / decision-making skills - Understanding and managing workload - Self-assessment	Discipline Discipline in terms of: - flight preparation - flight discipline (e.g. vigilance/ look-out, SA maintenance, operational & regulatory policy) - knowledge & skills maintenance - post-flight evaluation - self-discipline (managing stress, managing attitudes)
	Team skills - Performance monitoring - Leadership / initiative - Interpersonal skills - Co-ordination & decision-making - Team communication and SA	

Table 1: The knowledge, skills and attitudes that are the foundations of airmanship [5]

However, to achieve outstanding airmanship, aircrew must also adopt the values and principles that embody the airmanship philosophy. Hence training also has a role in shaping an airman’s entire approach to aviation.

TRAINING AND EVALUATING AIRMANSHIP

Airmanship has traditionally been acquired as a by-product of conventional training. It is developed by exposing trainees to plausible scenarios and discussing key airmanship points. The increasing number of accidents attributed to human error led to the introduction of dedicated training programmes to improve pilot judgement and co-ordination. However, airmanship relies on the integration of physical and cognitive skills, with knowledge and discipline and should therefore be trained holistically. This means that soft skills training should be integrated within “conventional” training rather than singled out for specialist treatment.

Training airmanship requires three essential elements. First, instructors must explain the basic concept about why airmanship is so important and the rewards it offers. This is necessary to embed the values and motivation needed to achieve airmanship excellence. Secondly, instructors must teach the knowledge, skills and attitudes that are the foundations of airmanship. Aircrew should also be provided with sufficient performance data, learning material and training facilities to enable them to continue learning between formal training sessions, thus fostering a culture of continuous learning. Finally, airmanship must be assessed thoroughly and objectively to provide feedback on the knowledge and skills that must be improved.

The following guidelines have been developed to assist in the design of airmanship training material and training programmes. The guidelines are divided into four main categories:

1. Introducing the concept
2. Overall teaching strategies
3. Teaching the foundations of airmanship
4. Assessing airmanship

INTRODUCING THE CONCEPT

1. Provide real-world case studies to demonstrate the importance and rewards of airmanship.
2. Use models of airmanship to present the foundations of airmanship and the levels of airmanship competency.
3. Develop a study guide that explains the principles and rewards of airmanship and stresses the importance of continuous learning and self-improvement.

OVERALL TEACHING STRATEGIES

1. Use a systematic approach to teach basic and higher-order skills. Early training should focus on psychomotor skills (manual flying), basic procedural skills (understanding of situations and procedures), and introduce the concepts needed later (e.g., systems knowledge). Intermediate training should refine psychomotor performance, complex procedural skills, and expose students to the range of less predictable situations that can arise and how they have been resolved in the past. Later training should focus on the development of higher-order skills such as problem solving.
2. Allow students simulator practise in between formal instruction to facilitate continuous learning, reinforce learning and aid retention.

3. Encourage students to keep a journal for recording minor errors during a flight and new techniques that were employed. Keeping a journal allows for a period of reflection, records tacit knowledge and provides direction for areas of improvement.
4. Provide examples of aviation problems that students may have to face or have already faced (problem-based learning).
5. Encourage *mental flexibility* by using multiple representations of training content using several kinds of media.
6. Avoid oversimplifying training content. Present a number of examples to make apparent, rather than hide, the variability and interconnections of concepts and themes. Knowledge should be highly interconnected rather than compartmentalised.
7. Use *cognitive apprenticeship* to teach cognitive skills. This approach borrows from the features of a traditional apprenticeship e.g. one-to-one teaching, but focuses on teaching cognitive skills. The role of the instructor is to make explicit the cognitive processes associated with problem solving and decision making, to teach tacit knowledge as well as textbook knowledge and to encourage students to try out different strategies and observe their effects.
8. Support students by performing parts of the task they cannot perform and gradually reduce the amount of “scaffolding”, shifting more of the control to the learner.
9. Encourage students to give reasons for their actions making their tacit knowledge more explicit.
10. Encourage students to try out different strategies and observe their effects. If students develop misconceptions, confront them with anomalies and counter-examples.
11. Provide opportunities for collaborative learning to create a culture of teamwork and increase motivation.
12. Use CBT to teach problem-solving skills in order to make the thinking processes of the learner explicit. Tailor instruction to suit the learner via a pre-test.

TEACHING THE FOUNDATIONS OF AIRMANSHIP

1. Teach discipline and attitudes from the outset.
2. Teach students to identify the hazardous attitudes associated with poor airmanship and the various antidotes (see Table 2). Egotistical attitudes are the antithesis of the values embodied in airmanship. Airmanship values include *maturity* — being able to admit a mistake and reverse a decision if necessary, and taking personal *responsibility* for ensuring safe flight and meeting mission objectives.

Hazardous Attitude		Antidote
<i>Anti-authority</i>	‘The regulations are for someone else’	‘Follow the rules. They are usually right.’
<i>Impulsivity</i>	‘I must act now, there’s no time’	‘Not so fast. Think first’
<i>Invulnerability</i>	‘It won’t happen to me’	‘It could happen to me’
<i>Macho</i>	‘I’ll show you. I can do it’	‘Taking chances is foolish.’
<i>Resignation</i>	‘What’s the use?’	‘Never give up. There must be something I can do.’

Table 2: The antidotes to hazardous attitudes [8]

3. Use case-studies to provide a context for technical knowledge.
4. Teach teamwork skills using videos and voice recordings of real-world examples, stopping the video at key points and discussing team interactions.
5. Teach strategies for managing workload (see Table 3). Modern aircrew have to cope with unprecedented levels of information that have the potential to overwhelm them. However, aircrew can be taught to manage their workload and maximise their spare capacity. Recognising when aircrew are overloaded (or underloaded) and taking steps to restore the balance is an important part of airmanship.

Workload Management Strategies	
1.	Be aware of own and team member spare capacities.
2.	Stabilise the aircraft and manoeuvre to a safe position before attempting to balance workload.
3.	Establish task priorities and filter irrelevant information.
4.	Put low priority tasks on hold.
5.	Delegate tasks to others.
6.	Take on tasks when others are overloaded.
7.	Manage distractions – recognise when aircrew are being distracted and re-establish priorities.
8.	Establish roles and responsibilities prior to each flight.
9.	Anticipate and rehearse plans during periods of low workload (also prevents underload).

Table 3: Workload management strategies [5]

6. Teach the fundamentals of situation awareness [10], how to recognise the signs of lost SA and how to recover SA (see Table 4). Put simply, situational awareness can be defined as “knowing what is going on, so you can figure out what to do”[11]. It enables aircrew to stay mentally ahead of an aircraft and develop the foresight needed to detect and resolve problems before they have chance to fully develop. Incident reports are littered with examples of aircrew who have made confident decisions based on inaccurate or lost SA; aircrew need to be able to assess the reliability of their own SA (metacognition) and take steps to regain it once it is lost.

Indicators of Lost SA	Steps to Regain SA
1. Ambiguity or confusion - feeling you are missing something, a sense of uncertainty.	1. Buy some time – manoeuvre the aircraft away from potential hazards.
2. Fixation – channelled attention or preoccupation on one activity or event.	2. Stabilise the aircraft.
3. Reduced frequency or poor communications - when we start to lose SA we stop talking.	3. Seek information – visual, aural, seat of the pants. Resolve any discrepancies and restore confidence levels.
4. Failure to stay ahead of the aircraft – reacting exclusively to immediate concerns rather than preparing and anticipating future events.	4. Learn from the experience - consider what cues were available that could have prevented a loss of SA.
5. Failure to meet targets during a mission e.g. ETAs.	
6. Use of undocumented procedures or violation of a minimum.	
7. Attempting to operate aircraft systems outside of known limitations.	

Table 4: Strategies for Managing SA [3]

ASSESSING AIRMANSHIP

1. Assess airmanship qualities at an appropriate stage of learning. Student confidence can be fragile and will be dented if evaluated on skills that are too advanced.
2. Encourage students to perform self-assessment — a technique that has been shown to significantly improve retention of information.
3. Use objective data to assess physical skills (e.g. bombing accuracy, flight profile accuracy), thus providing concrete feedback for the student.
4. Define and use performance standards for both physical and cognitive skills — this ensures consistency in student evaluation and informs students of their position on the performance ladder.
5. Use “think-aloud” protocols as a source of data for assessing cognitive skills.
6. Use “concept maps” to test students’ understanding of the interconnections between knowledge elements.
7. Use the “secondary task” method for assessing spare capacity. This involves systematically loading students with increasing demands until the point is reached at which primary task performance breaks down. This provides an indication of the students’ spare capacity. Systematically increasing levels of workload can also be used to practice workload management strategies. The technique should not be used for *ab initio* students.
8. Introduce events during simulator training as an objective means of assessing airmanship performance. Students score a “hit” if they demonstrate the required behaviour and a “miss” if they

fail to demonstrate the required behaviour. Events could include emergencies to monitor students' skill in priority allocation, unscheduled aircraft to test student lookout discipline and erroneous aircraft communications to test communication skills.

9. Evaluate airmanship by assessing the processes employed in a mission and not just the outcomes. This provides a more diagnostic view of student performance than simply outcome measures alone.

An integrated approach is needed for the training of airmanship — an approach which combines traditional “stick and rudder skills” with higher-order cognitive skills and attitudinal skills, and an approach which employs modern teaching strategies inspiring students to seek performance excellence and encouraging greater accountability for learning development.

CONCLUSION

Within the aviation community, there are many definitions and concepts of airmanship. It is our contention that airmanship is logically defined as a personal state that enables aircrew to exercise sound judgement, uncompromising flight discipline and skilful control of an aircraft within a situation.

There are several indicators of effective airmanship. Primarily a good airman is someone who prevents things from going wrong by maintaining situational awareness, using foresight to anticipate potential hazards and making sound plans that take them into account. However, it is perhaps easiest to see effective airmanship in action when problems arise. Then, effective aircrew correctly assess the dynamic situation, apply sound judgement and take decisive and appropriate action. In doing so, aircrew manage the available resources and prioritise their goals; demonstrate good discipline and strong teamwork, communicate clearly to all appropriate agencies, and employ comprehensive knowledge and considerable expertise to the situation.

Whilst it is true that airmanship is a personal quality, and that individuals do vary in their natural ability for it, aircrew can be trained and motivated to achieve airmanship excellence through application of the Foundations of Airmanship model. Airmanship training centres on the building of three key skills of judgement, control and discipline using a defined series of knowledge and skills. However, airmanship is more than having the requisite skills and knowledge; it is about having an appropriate attitude and a desire to perform optimally at all times— this personal conviction will enable aircrew to attain the highest levels of airmanship performance.

Outstanding airmanship can only be achieved by placing airmanship training at the very heart of a training system rather than as an adjunct. An holistic approach to airmanship training is essential to enable aircrew to meet the new and significant challenges of modern aviation.

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