

Green Paper

Knowledge and Skill Requirements for future Aircraft Maintenance Technicians (AMTs)

Workshop

June 30th - July 1st 2011

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Index:

Participating Organizations.....	1
Executive summary.....	3
Purpose and scope.....	3
Introduction.....	3
Problem statement and historical background	4
Results.....	4
Method.....	5
Discussion.....	5
Regulatory environment.....	5
AMT training and safety behaviour	6
Recruitment.....	9
Findings from other areas of the industry	9
Next Steps	9
Summary	10
Appendix A	11
Appendix B	12
Appendix C	13
Appendix D.....	14

Participating Organizations

Austrian Airlines



Austro Control GmbH



Federal Office of Civil Aviation,
Switzerland

Bundesamt für Zivilluftfahrt (BAZL)



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

European Aviation Maintenance Training Committee,
Netherlands



Federal Aviation Administration, USA



International Civil Aviation English Association, UK



Link&Learn Austria



Lufthansa –Technik Aero Alzey,
Germany



Lufthansa Technical Training, Germany



Nayak, Germany



SR Technics, Switzerland



Swiss Aircraft Maintenance Association,
Switzerland



Swiss Aviation Training,
Switzerland



Executive summary

Present and future aircraft generations increasingly involve new technologies and materials. Aircraft maintenance seeks to maintain and improve its low rate of accident causes and therefore needs appropriately qualified people. A group of maintenance and training experts discussed the necessary skills of future AMTs (Aircraft Maintenance Technician) on the basis of actual experience and predicted developments. This paper intends to launch a wider discussion which should lead to general industry recommendations and proposals to drive regulatory changes.

The group agreed that the importance of human factors aspects in aircraft maintenance will increase and that other skills such as information management and situation awareness may outpace the purely technical skills.

Changes affecting aircraft maintenance also lie in the economic/social working environment and the regulatory framework. Increasing economic limitations and globalisation in the sense of workplace mobility and inter-cultural cooperation increase the potential for maintenance errors. The ongoing regulatory process increasingly occupies more resources, adds complexity, and makes proper 'regulation awareness' difficult to understand. Such factors may distract from the basic maintenance safety premises. These aspects require measures beyond AMT training, e.g. awareness training of management and authority personnel, or action at political level.

Training contents and possibly training methods should be adapted. It appears that at least culture (safety and company) and human factors should be given a stronger focus. It is suggested that some guidance could be of use already at the stage of recruitment.

Purpose and scope

This paper sets out the position of a group of industry experts from the fields of aviation maintenance, maintenance training, regulations, human factors and aviation safety. The group came together to discuss future AMT training and to generate support for the issue with different industry stakeholders.

Introduction

ICAO predicts air traffic to double by 2020 with a continuous annual increase of 5% up to 2050. New technology, new aircraft systems, unmanned aircraft vehicles etc. will all demand the same or higher safety, efficiency and environment standards. In this context of new technologies, globalisation and new demanding information strategies, AMTs will require new competencies and will need to integrate them into their daily work. Special emphasis was given to the inter-relationship between technical and human subsystems, which are inseparable in aircraft maintenance. A mission-oriented attitude should be established as a basic concept for future AMTs (holistic approach) and this should be integrated into the training process.

Problem statement and historical background

In the context of the technical aspects of an aircraft, aviation training history shows that the AMT's knowledge and skill requirements are a function of the evolution of aircraft technology. A mission oriented attitude should be established as a basic concept for future AMTs (holistic approach) and this should be considered to be integrated into the training process.

With the advent of better improved information it becomes increasingly clear the main contributing factor is not:

- insufficient knowledge
- insufficient hand skills

Supporting accident and incident data to date may indicate that the industry has done well in terms of training AMTs for the required technical knowledge and skill elements. With this background it is suggested that industry will find ways to correctly and successfully train AMTs to meet any future developments regarding these elements.

As a generalisation, young people entering the industry do not have the same hand skills as in the past. Today's "computer generation" have different skills. However, hand skills are not where today's AMTs are making errors. It is likely that for some AMTs, the traditional hand skills may become less important with a maintenance trend towards "replace" rather than "repair".

It is evident from the available accident and incident data that the human element is the main contributor to most accidents and incidents. The human element has two aspects: Human-machine interface and human-human interface.

Research in aviation Human Factors (HF) initially focused on flight operations (aircrew) and air traffic management with aircraft maintenance receiving attention later. It is now recognised that HF contributes to more than 85% of all accidents and incidents and that maintenance is prominent amongst causal factors.

Even though human factors are now a well established part of training and organisational regimes, they are still underestimated and will be of increasing importance in the future environment.

It is suggested that the industry should not discard the elements in which it has done well but future training must change to take the facts, as known, into account.

Results

The IATA Training and Qualification Initiative (ITQI) report, geared towards the aviation industry's need for the next generation of licensed professionals, showed substantial

numbers of AMTs predicted to be required in most parts of the world in the coming years. This translates into a challenge for the industry, not just in terms of safety to absorb so many newcomers without diluting the safety imperative, but also in terms of training.

The training and qualification challenge also has to be considered in the light of changing employment patterns. The trend is toward contract maintenance or contract maintenance personnel. That trend means there will be a variety of multi-level training requirements for not only licensed personnel but also non-licensed workers.

It is likely that the functions of AMTs will further diverge between airline operations (where AMTs may well be “specialists”) and general aviation (where AMTs may well be “all-rounders” and more “hands-on” as understood in the traditional sense).

The changing of basic or foundation training, which may be perceived as being too academic or knowledge focussed today, may be an area for future discussion.

To arrive at the Future Knowledge and Skill Requirements for AMTs, discussion centred on the AMT's role to date and how it needed to become mission focused. This implied changing the paradigm to a more holistic approach. AMTs must be able to integrate knowledge, know-how, sensory observation, interpretation of factual, graphic and textual data, they need data processing skills, contextualised decision making skills involving specific situational awareness, common sense, hand skills, communicational language etc. They must be motivated to adopt a positive corporate safety culture and to accept the personal responsibility that comes with the maintenance job. To aid the discussion three areas were considered: -

1. Technical skills (those skills that are technology driven)
2. Non-technical skills (skills to be considered at the individual and/or team level but not technology driven)
3. Cultural issues (those issues that are at the organisational level)

Method

Elements considered important for the future AMT were listed under each of the above areas. Experts were then asked to rank them in order of importance (3 = very important, 2 = important, 1 = to be considered in the future). These were then further refined to arrive at the lists given in the appendices.

Appendix A: List of Ranking: Technical skills (technology driven)

Appendix B: List of Ranking: Non-technical skills (individual team level)

Appendix C: List of Ranking: Culture (Organizational level)

Discussion

Regulatory environment

As the training and qualification standards for Certifying Staff are regulated by law, in the interests of a global approach, the subject of the regulations should be addressed. The

objective should be to obtain a common regulatory understanding and movement towards global harmonization. Such harmonization should strive to achieve identical safety goals within the context of world cultures. Regulations must avoid seeking to level out differences by regulating, in deep detail, of how things shall be done and/or organised.

Attempts to achieve a level playing field across some authorities has led to complex, heavily inter-related regulations. These are often difficult for practical people to understand, bring different interpretations by different authorities and thus may bring inherent safety risks. A side effect of “making regulations for everything” is that people become uncertain in applying the regulations. People no longer take, or want to take responsibility and put all responsibility onto and into the regulations. This can have a spiral effect. The AMT starts to complain: “We have no clear regulation or procedure established to carry out our work.” This often results in establishing new amended regulations and new amended procedures. As a consequence the AMT faces a multitude of regulations and procedures and this may decrease his self responsibility and self reliance and further on his motivation. Therefore an evaluation of working behaviour and working conditions under the current regulations should be conducted. An adoption or amendment of regulations should be based on the results of an evaluation process.

It is proposed to redefine rule-making as stating and verifying the required outcomes of training instead of trying to explain ways to do things for a multitude of different cultures.

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The changing of basic or foundation training, which may be perceived as being too academic or knowledge focussed today, may be an area for future discussion.

AMT training and safety behaviour

Along with knowledge and skills, attitude and behaviour are considered the most important factors for AMTs. As mentioned above, the industry appears to have done well in terms of knowledge and skill training. Attitude and behaviour now need to be integrated into training so that the safety risks, which may have been reduced by the efforts to date of Human Factors training, may be further reduced.

Future AMTs and perhaps also Airworthiness Authorities must have situational awareness (the “what am I doing and why am I do this”?) Maintenance tasks are the same all over the world but AMTs work under the focus of different attitudes, different mentalities and different social systems, but that does not mean that a variety of cultural approaches to maintenance cannot achieve the same safety goal.

AMTs should be trained into a safety culture. This safety culture must mesh with, yet override societal culture. It is asked as to whether there can be a global safety culture? The need for management behavioural change in safety culture is noted.

The Aviation research lab of the University of Illinois defines safety culture in the “Technical report ARL-02-03/Faa-02-2” as follows:

“Safety culture is the enduring priority placed on worker and public safety by everyone in every group at every level of an organisation.”

In turn each individual worker must share that goal and be able to understand and express their individual contribution to the corporate safety culture. In a healthy safety culture each individual must:

- Take personal responsibility for safety,
- Act to preserve, enhance and communicate safety concerns,
- Strive to actively learn,
- Adapt and modify (both individual and organisational) behaviour based on lessons learned from mistakes,
- Be rewarded in a manner consistent with safety values.

Safety cultural awareness is not automatic. It must be learned through a maintenance AMT’s career. This happens by seeing good examples and by safety cultural awareness integrated into all training programs.

The concept of the AMT being trained to have a mission-oriented (holistic) working attitude should be established. In this context, the mission is the safe preparation, departure, flight and arrival of the aircraft at its destination. There is considerable overlap and interdependence between many of the technical and non-technical skills identified in the group’s lists (see appendices A,B, C). In particular, changing training methods to a more holistic approach highlights the fact that many skills and the attitudes required to implement them should be regarded, practised and trained holistically. Many of the conventional “categories” and “compartments” used in production and training may well inhibit the effective integration of skills. Failing to establish such a concept keeps the AMT in the present dilemma between the operational (financial) and technical (safety) requirements.

It is expected that analytical skills will widely replace “practical” ones. Other factors identified which may influence the future environment are economic pressures, local over-regulation and non-consistency across continents, attractiveness of the job, focus of training requirements on duration and / or knowledge instead of competence. Further factors include coping with new materials, and new technologies. This includes, for example, integrated systems, automatic monitoring and reporting to home base, the shift from repair towards exchange / replace, and from blue collar to white collar work.

The current licensing / training system has a strong knowledge base. In the interest of safety it should be possible to integrate the required non-technical elements into this system. European Aviation Safety Agency human factors regulations have encouraged such integration.

Future expectations of young AMTs, the pressure to succeed, the fear of failure, and uncertain future prospects all create stress situations. These often lead to personal difficulties that may increase the incident and accident risk. Further, it can be recognized that from time to time ethnic and moral values affect interaction between colleagues that

can give rise to problematic situations.

Working in a critical and safety-endangering occupation requires a positive work attitude, high motivation, and high self esteem. Future AMTs must develop the following factors:

- Sense of responsibility
- Internal and external motivation
- Inner willingness for problem solving competence
- Rationale and the capability for decision making under stress and
- The readiness to make optimal use of his/her own abilities
- Job satisfaction in accomplishing a safety critical task

The development of mental strength and the development of motivation are rarely or almost never part of the training or continuing education of AMTs. It should be noted that mental strength and abilities are natural methods to reach optimal performance and success even under unfavourable conditions. Mental training techniques have no negative after-effect and activate the natural bio-psychological processes.

The future AMT will be confronted with situations which require more than just technical factual knowledge due to new technologies, abstract trouble-shooting measures and various regulations which must be fulfilled in the narrowest time-frame. This involves risks for wrong actions and decision-making. Stress may increase when people from different cultural backgrounds or with different modes of behaviour work together. All these influencing factors, not covered in today's training, must be trained.

Although the present training programmes include Human Factors, they miss the mental ability to put such Human Factors knowledge into practice.

Competency-based or competency-oriented training, widely recognised as a prerequisite for future AMTs, is based on the principle of training to acquire skills to ensure a successful outcome. This implies being able to integrate knowledge, know-how, sensory observation, interpretation of factual, graphic and textual data, data processing skills, contextualised decision making involving specific situational awareness, common sense, hand skills, communicational language etc. Whilst it may or may not be desirable to regulate for language the subject cannot be ignored.

Language skills are also important for the future responsibility of an AMT. Language, like data processing skills, is an example of a key transversal skill which, with attitude, underpins the successful acquisition and implementation of most of the other skill items identified by the group. The developments in both aircraft and infrastructure technology, and the regulatory environment, are all driving the use of language quantitatively and qualitatively. It may be misleading to refer to 'technical aviation English' since this has long been associated with reading procedures and system descriptions, i.e. essentially 'passive' skills. AMTs are increasingly called upon to use language in many different tasks, often 'actively' and 'creatively', as an integral part of a decision-making process: troubleshooting, data seeking, report writing, communication with flight crew and other team members, understanding training commentaries, note taking, clarification strategies etc.

Also to be taken into account is the use of and respect for technical documentation; very often inadequate knowledge of documentary conventions (revisions, effectivity, titles, cross-references, upper and lower case etc.) hampers effective interpretation.

What has become clear from the ways in which especially the younger generations learn and use language is that there is a need for the above mentioned tasks to be taken into

account holistically and more attention to be paid to developing the cognitive processes which are involved in performing them successfully. Similarly, every opportunity should be taken to integrate the various uses of language into production: briefings, debriefings, practical training, On-Job-Training, team building, single shared corporate culture, training, traceability etc.

Recruitment

A major European organisation's recent staff survey found that in the near future they may not need as many people with certifying privileges as in the past. It may well be that in Europe, with the advent of EASA, the goal of owning a licence was seen as the requirement. Industry is now confronting the problem of having workers holding licences but not using their full competences. It was noted that the military will increasingly be using the same regulations and requirements as civil aviation which may compound this phenomenon.

Recruitment and assessment of candidates wishing to enter the industry should focus on the required skill-sets. Recruiters should be made aware of the required physical and mental attributes to ensure that the right people are employed. Consideration should be given to pre-aviation career training for:

- Sense of responsibility,
- Internal and external motivation
- Inner willingness for problem solving competence
- Rationale and the capability for decision making under stress and
- The readiness to make optimal use of his/her own abilities

The above should also be preparatory to training to obtain a license. It would help to improve the learning process itself, making the basic training more efficient and give people the opportunity to apply these techniques already during their practical phases. It would prepare future AMTs to withstand difficult challenges and give them the ability to remain motivated and proactive in the working process. It may also help to make the profession more attractive to young people in the future.

Findings from other areas of the industry

Whilst the discussion focus was on maintenance and the training of AMTs, Human Factors and Air Traffic Control studies and industry group studies confirm similar trends.

Next Steps

The European Aviation Maintenance Committee (EAMTC), being an industry body of aircraft maintenance training experts, OEM (Original Equipment Manufacturer) training experts, Regulatory Authority personnel and personnel associated with other industries closely aligned with aviation maintenance training, has expertise that may be applied to

further develop the study of future AMT training.

The EAMTC: -

- has current knowledge of and understands the skills of AMTs
- knows the current aviation maintenance system
- understands the current regulatory environment
- has the necessary competence to determine what maintenance and maintenance training will look like in the future
- has the liaison with the Regulatory Authorities to assist in implementing new/changed knowledge and skill requirements for the future

This “Green Paper” will be presented to the European Aviation Maintenance Training Committee in order to gather feedback. Based on the feedback, a course of action may be proposed.

Summary

- Knowledge and skill training for maintenance AMTs has been done well to date
- Training should evolve taking the historical data into account
- Non-technical skills should be an integral part of AMT training
- Regulations should be simplified and embrace the above points
- This paper will be presented at the next available EAMTC meeting

Appendix A

List of Ranking: Workshop: Future Knowledge and Skill Requirements for Aircraft Maintenance Technician:																			
1= low priority;																			
2 = medium priority;																			
3= high priority																			
14 participants:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	sum of points	sum of priority 3	sum of priority 2	sum of priority 1	
Technical skills (technology driven)																			
· Data processing skills (getting the right information)	3	1	2	3	3	2	3	3	3	3	3	3	3	3	38	11	2	1	
· Competency-based training	2	3	3	3	3	3	3	2	3	2	3	2	3	3	38	10	4	0	
· Digital skills increase (Human Machine interface skills - HMI)	2	2	3	1	3	2	2	2	3	3	3	3	3	3	35	8	5	1	
· Skills to support the new system technology	3	2	3	2	3	1	3	3	2	3	3	2	2	2	34	7	6	1	
· Increase in Hand skills	3	3	2	1	3	3	2	2	2	3	2	2	3	1	32	6	6	2	
· Language (technical aviation English)	2	3	3	1	3	1	2	2	2	3	2	1	2	3	30	5	6	3	
· Electrical, electronical and IT experts	2	1	2	1	3	3	2	3	2	2	2	3	2	2	30	4	8	2	
· Higher importance of new materials	1	2	2	3	2	1	2	2	1	3	3	1	2	3	28	4	6	4	
· Generalization (B1 & 2 à B) and specialization	3	1	1	1	1	1	1	1	1	1	2	3	2	2	21	2	3	9	
· Technical familiarization for Management	1	1	1	1	1	1	1	1	2	1	3	2	1	2	19	1	3	10	

Appendix B

List of Ranking: Workshop: Future Knowledge and Skill Requirements for Aircraft Maintenance Technician:																		
1= low priority;																		
2 = medium priority;																		
3= high priority																		
14 participants:																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	sum of points	sum of priority 3	sum of priority 2	sum of priority 1
Non-technical skills (individual team level)																		
· Decision making	2	2	3	1	3	3	3	3	3	3	2	3	3	3	37	10	3	1
· Change training method to more holistic approach	1	3	3	3	2	3	2	3	3	3	3	3	2	2	36	9	4	1
· Problem solving	2	2	3	3	3	2	3	3		3	2	1	3	3	33	8	4	1
· Awareness of human limitations (stress management)	3	3	1	3	1	3	1	3	3	2	3	3	2	2	33	8	3	3
· Situational awareness	3	2	2	3	2	1	2	3	1	3	3	2	3	3	33	7	5	2
· Communication training (interpersonal social skill)	2	3	3	2	2	2	2	3	2	3	3	1	3	2	33	6	7	1
· Leadership	2	3	3	2	3	2	1	2	2	2	3	2	3	3	33	6	7	1
· HMI	3	2	3	1	3	3	2	2	2	3	2	2	3	2	33	6	7	1
· Self-confidence building	3	3	3	2	2	2	1	2	2	2	3	2	3	2	32	5	8	1
· Assessment (self and peer assessment)	2	1	3	3	2	3	1	1	2	2	3	3	3	2	31	6	5	3
· Team building skill (group dynamics, peer pressure)	3	2	3	2	3	1	1	2	2	2	3	2	2	3	31	5	7	2
· Respect for technical documentation	1	1	1	2	2	3	2	2	2	3	3	2	2	3	29	4	7	3
· Data processing skills	2	1		1	3	2	3	2	2	3	3	1	2	2	27	4	6	3
· Reporting skills	2	1	2	1	2	3	1	2	2	3	2	2	2	2	27	2	9	3
· Assertiveness	3	1	3	2	1	1	1	2	2	1	3	1	2	2	25	3	5	6
· Commercial awareness (commercial customer driven)	1	3	2	1	2	2	1	2	1	1	2	3	2	2	25	2	7	5
· Communicational language	2	2	1	1	2	1	2	3	2	2	2	1	1	3	25	2	7	5

Appendix C

List of Ranking: Workshop: Future Knowledge and Skill Requirements for Aircraft Maintenance Technician:																		
1= low priority;																		
2 = medium priority;																		
3= high priority																		
14 participants:																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	sum of points	sum of priority 3	sum of priority 2	sum of priority 1
Culture (Organizational level)																		
· Attitude / behaviour	3	3	3	3	3	2	3	3	3	3	3	3	3	3	41	13	1	0
· No blame reporting culture	1	2	3	3	3	2	1	3	3	3	3	2	3	3	35	9	3	2
· Mission focused	3	1	3	1	3	2	3	3	3	2	2	3	3	3	35	9	3	2
· Single, shared corporate culture	3	3	3	1	3	3	2	2	2	2	3	2	2	2	33	6	7	1
· Shared responsibility for safety culture	2	1	3	3	2	3	1	2	2	3	3	3	2	2	32	6	6	2
· Clarity in the message of safety culture („plain message“)	2	2	3	3	3	3	1	2	2	2	3	2	2	2	32	5	8	1
· Make safety culture "visible"																		
· Organizational culture in leadership (leadership and supervisory)	1	2	3	2	2	1	2	2	1	3	3	2	2	3	29	4	7	3
· Intergenerational awareness/processes	2	2	2	2	1	1	3	3	2	1	3	2	2	2	28	3	8	3
· respecting different cultures (from training organization perspective)	1	3	2	3	1	2	1	2	2	2	2	2	2	2	27	2	9	3
· Gender	1	2	1	2	1	1	2	2	2	1	2	1	1	2	21	0	7	7

Appendix D

Workshop and participants

Convened at InfoWerk, Zirl, Austria on 30th June and 1st July 2011 to discuss the “Future Knowledge and Skill Requirements for Aviation Technicians”

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It is noted that the participants are (mainly) from north European countries. More input is needed from other parts of the world.