

Pilot Training Compass:

*“Back to
the future”*



ECA

European Cockpit Association

Table of contents

Keynote	3
Introduction	5
Philosophy of training & education	7
Fundamental concepts	7
Selecting the right stuff	12
Skills & competencies	15
Career path	22
The who and how of training	23
Training delivery methods	24
Instruction cadre	26
Conclusion	27

Photo credits

Cover: Kris Van der Plas	p. 20 VNV
p. 3 Wikipedia	p. 21 ECA
p. 4 Wikipedia and US Library of Congress	p. 22 Kris Van der Plas
p. 5 Kris Van der Plas	p. 23 Kris Van der Plas
p. 7 Kris Van der Plas	p. 25 Kris Van der Plas
p. 11 Nico Voorbach	p. 27 Erik Coeckelberghs – Aviation Photocrew
p. 12 SEPLA	
p. 13 Ismael Jordá	
p. 14 top: SNPL / bottom: SEPLA	Fig. 1 IATA
p. 16-17 Ariel Shocrón	Fig. 2 Eurocontrol
p. 19 Fernandez Chinchilla	Fig. 3 ICAO
	Fig. 4 Boeing

1891
1903
2013

1891. In the outskirts of Berlin, Otto Lilienthal, a young engineer fulfilled his dream, and with the help of a machine ... he flew.

1903. Kitty Hawk, a tiny outpost in the dunes of the US east coast became a major part of history. Wilbur and Orville Wright set out to conduct what today is broadly acknowledged as “man’s first powered flight”.

2013. Now a mere 110 years later aviation has changed quite a bit... and so have the demands for the profession of an airline pilot. The profession did not exist in those early days of aviation. It has developed over the years.

But what is it that defines a proficient pilot?

Lilienthal conducted extensive studies on birds, striving for thorough comprehension of the physics of flight. The Wrights operated a bicycle and motor shop which enabled them to develop the necessary mechanics.

They were no daredevils, but well prepared for the dream they were pursuing.

Keynote

Pilots need a very unique set of skills, competencies, abilities and personality that partially has to be present as a prerequisite. Some of these can be trained. Others need to develop over the years.

Today’s tasks range from pure handling of the aircraft, to managing the whole event of a commercial flight which requires a completely different set of skills.



Picture 1 Otto Lilienthal, Berlin, 1891 (© wikipedia)

But is it true that everything that Lilienthal, the Wright brothers and all the other visionaries needed to know is not required to operate today’s “heavier-than-air flying machines”?

Lilienthal’s polar curves are still valid and the physics of flight haven’t changed since the early days. The most demanding task today is the ability to crossover between that basic aviator knowledge and the modern management of commercial flying. This switch can only function properly if both skill sets are fully developed and constantly enhanced.

- THE RATIONALE BEHIND -

Training seems to be the number one field that airlines like to outsource, which means they are more and more losing the control over the qualifications of one of the most important safety barriers: the flight deck crews.

Authorities, regulators, flight training organisations and the industry themselves all have different points of view on flight crew training, many of them are rather cost than safety driven.

Whilst the final product of training - an airline pilot with the right skills, competencies and personality - is the same throughout, there are many different ways and programmes to achieve them.

While individual training programs and syllabi always need to be adjusted to the traditional, legal and cultural environment it is essential that the whole subject of pilot training is dealt with in a systemic approach, from the very beginning to the last flight.

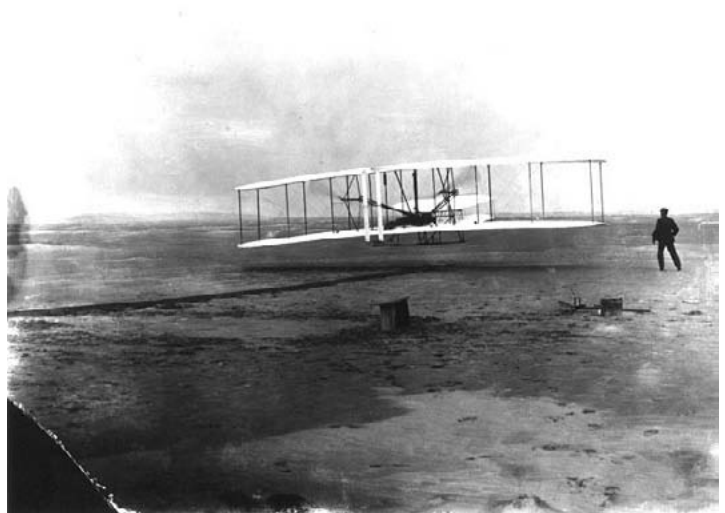
Pilot training experts from all across the globe have gathered to develop their vision of future pilot training.

“Pilot Training Compass: Back to the future” is intended to:

- » serve as a guideline for our representatives in various projects and committees, both international and national. Rather than being reactive and “only” defending the standards, pilots need to go out and tell the world what we need
- » be a proactive step towards the industry
- » be an open invitation to all stakeholders to discuss with pilots on what “learning to fly” really entails.

“Pilot Training Compass: Back to the future” addresses:

- » the entry into the business, the necessary prerequisites
- » the initial, intermediate and advanced stages of training as well as recurrent training
- » the requirements for modern aircraft training and what it takes to be fit for future ones
- » the overall scope of the pilot’s profession, apart from operating the aircraft and the necessary prerequisites and training
- » the way forward to implementation
- » the overall system.



Picture 2 Wright brothers, 1903 (© wikipedia - US Library of Congress)



Introduction

The airline industry, perhaps more than any other, has throughout its history been subject to cyclic variations of the world markets. Some of these have been quite spectacular and damaging for the industry. However, these crises do not mask the underlying growth trend.

In the “Challenges of Growth 2013” document, Eurocontrol looks at the implications of the recent economic and traffic downturn and the effect on the latest long-term flight forecast, published in 2010. In all scenarios the effect of the current crisis is still present in the 2030 forecast, but the trend is also very clear: about 3% annual growth in traffic volume for scenario C.

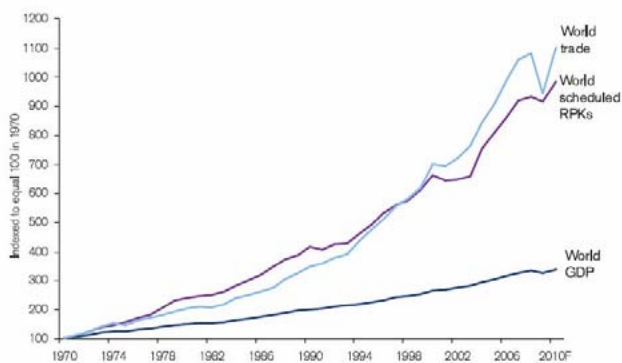


Chart 1: Air travel has expanded tenfold in the past 40 years
Source: ICAO, IATA, Haver

Figure 1: Source: IATA Vision 2050

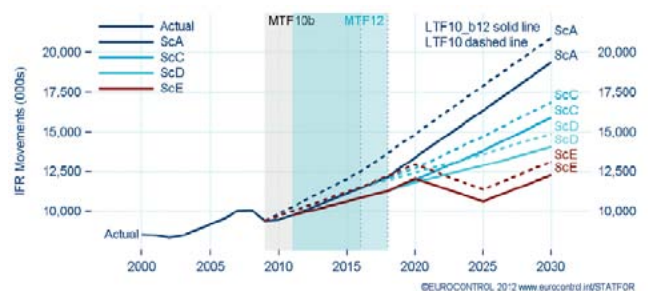


Figure 2: EUROCONTROL IFR movements forecast - challenges of growth 2013; ScA global growth; ScC regulated growth; ScD fragmenting world; ScE resource limits

For the global forecast the trend is even more upwards: ICAO counts on a most likely growth of 4,6%. Let us consider what that means for a moment. If that growth becomes reality then in 15 years twice as many people will be flying compared with today's traffic.

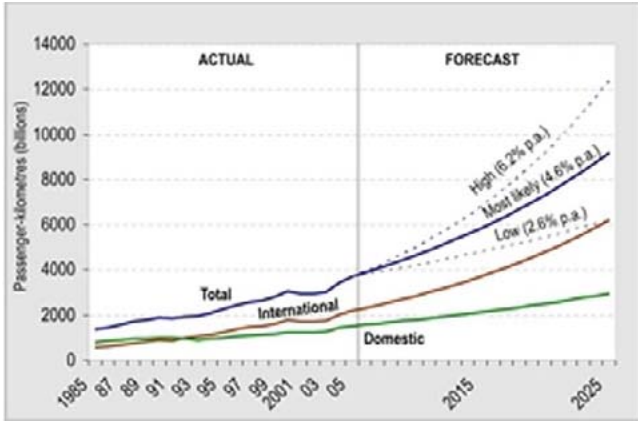


Figure 3: ICAO World passenger traffic to 2025 scheduled services - ICAO website: outlook for air transport to the year 2025

Boeing calculates the need for new pilots in the timeframe 2012-2031 to be 100.900 for Europe and 460.000 globally. This begs the question: where are we going to find those pilots and how are we going to train them?

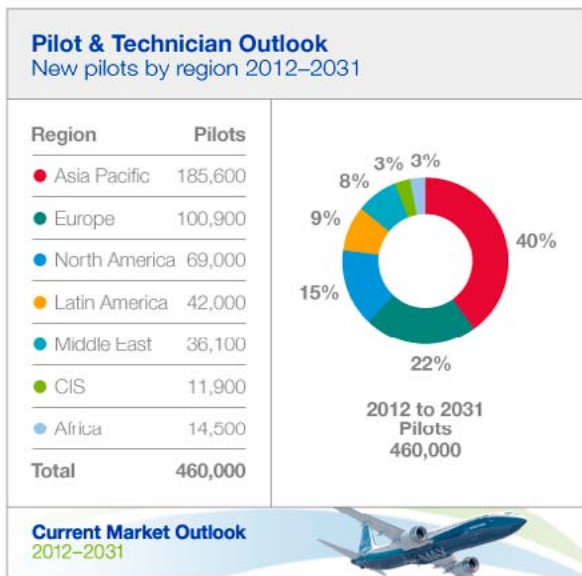


Figure 4: Introduction Boeing pilot outlook 2031 - © Boeing

Against this background it is no wonder that in recent years there has been a debate, increasing in intensity, about pilot training. This debate has expanded to include a discussion about the appropriate level of experience required for a new hire airline pilot. Much of the input to the debate has focussed on ways of reducing the cost burden of training while at the same time increasing the speed of reaction to business growth opportunities. In other words: how can we train more people faster? Against a business background featuring growing competition, and an increasingly demanding economic environment, this is understandable. The problem is this is a one-dimensional approach and as such risks being an incomplete one. How do we deal with automation for example? The increasing amount of automation found today on the flight decks may lead some to believe that pilots can do with less training. “Pilot training compass: Back to the future” will show this to be a false claim.

Meanwhile some regulators have promoted “quick fix” solutions to training shortfalls. These, solutions, although making for good headlines, fall into the trap of being too simplistic to be completely effective.

A more comprehensive review of pilot selection, initial and on-going training, must be carried out.

“After all, history has shown time after time that excellent and in-depth professional pilot skills are a pre-requisite for safe operations. These skills will stand up even under the most demanding of circumstances.”



Philosophy of training & education

1. Fundamental concepts

What defines a good pilot? To answer this question it is a good idea to reflect about the pilot role: what does the job require: aviators or system managers? The answer is that the job requires both skill sets and the ability to switch between the two as rapidly and frequently as the circumstances require.

While much of the work is procedural in nature, pilots have to be trained to be able to depart from linear thinking and quickly shift to “thinking outside the box” in order to deal with unexpected and undefined events. This is a key ability to prevent an accident from happening. A pilot needs to be able to develop skill sets that include core, basic, and management skills. This is represented in the triangles in Figure 5. The triangle on the left demonstrates a skill-set that requires more core and basic skills than management (such as when performing a hand-flown approach),

while the triangle on the right reflects a skill-set that requires more management skills than core skills (such as flying a coupled Required Navigation Performance approach). The paradigm shift in pilot training is to bring closer together these skill sets to enable the pilot to seamlessly shift between the two.

Being a professional pilot now and in the future requires very specific skill sets and competencies. Some of these can be trained, some not. This means they have to

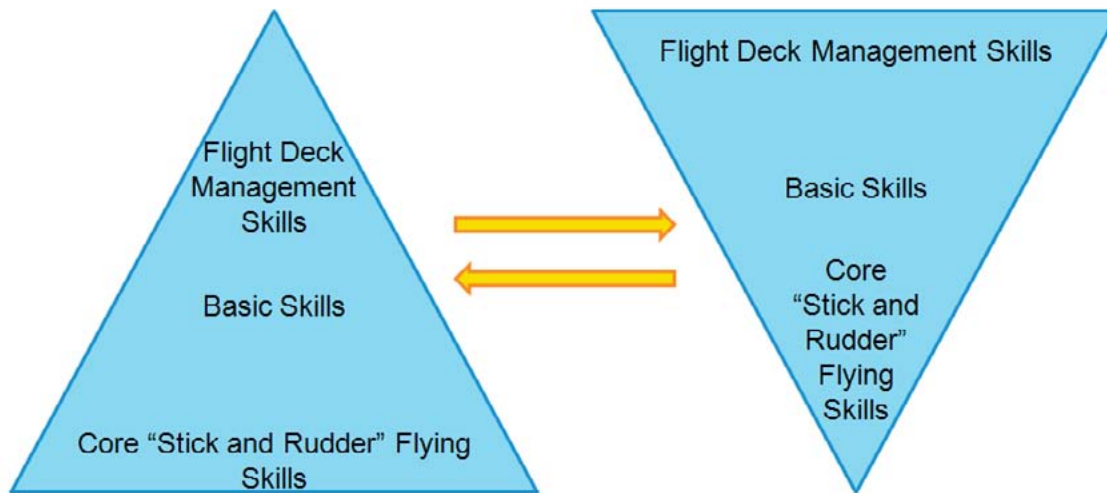


Figure 5: The paradigm shift: the importance of the different skill sets varies with circumstances. An effective training programme must be aimed at first reconciling these skills and then optimising the interplay between them.

be present in the candidate pilots and some sort of selection is necessary to filter out the most promising pilot material.

Professionalism can only be created by combining a thorough education with a constant development throughout the entire career of a professional pilot. In order to create a programme which maximises the potential of the pilot, it is important to acknowledge the difference between training (which develops response structures) and education (which develops airmanship).

Managers in charge of training programs (either ab initio or recurrent training) need to be mindful that low costs should not be driving the program but rather high quality. The pilot, as the ultimate safety barrier, should receive the highest quality of training.

“An early investment in good basic training will result in big savings later when the pilot is flying the line”

Also, regulators need to understand the needs of training. Legislation should not consist of fuzzy rules leaving room for too much interpretation. No, legislation should

be prescriptive enough to ensure a minimum quality in and quantity of training and thus guarantee safety.

The rapidly evolving aviation operating environment requires airlines to adapt continuously to maintain the viability and relevance of their training programs. The traditional approach of curriculum construction largely influenced by what operators and regulators “think” should be trained, is however no longer effective. In addition, lack of pilot involvement contributes to these deficiencies. Decreasing availability of resources has played an additional role in the pilot training program development and delivery.

These issues have forced us to take a fresh look at training strategies for the future. Modelled after the successful Safety Management System (SMS), the Training Management System (TMS) can deliver benefits to flight training organisations, airlines, regulators and pilots.

The TMS is largely based on the core principles of SMS. Just like an SMS system, the TMS will be data driven and rely on feedback from training programs. An oversight body with major stakeholder involvement will validate the success of the TMS.

The objective of a TMS is to provide a structured management system to control risk in operations. A quality training program plays a key role in risk management by giving the pilots the technical and non-technical tools to minimize risk.

Safety is a managerial process shared by the regulators, operators, flight training organisation, airplane manufacturers, and pilots. In order for the pilot training program to be successful, the education, awareness, and input of all these stakeholders are crucial. The TMS starts with the design and implementation of organisational processes. Every stakeholder involved in pilot training needs to understand his responsibility in the Training Management System so that each individual receives the necessary training to be competent and confident in exercising his/her job.

Training Management System (TMS)

- » uses a well-defined system to identify, construct and deliver curriculum that is relevant and innovative, without wasting resources on items that are not
- » allows regulatory bodies and agencies to oversee a well-defined process that ensures compliance and quality
- » is data driven
- » incorporates a feedback mechanism that allows to continuously evaluate the training program
- » has pilots “seated at the table” when their training programs and needs are discussed.

The core components of a TMS include a “Training Action Group” and a “Training Review Board” (TAG and TRB). These two groups operate independently within the TMS with as common goal ensuring the best possible training for the pilots. The TAG uses a data driven approach to establish training objectives, set priorities, recommend changes, and monitor the effectiveness of changes to the training syllabus. The TRB ensures compliance to stated processes and objectives through the use of anecdotal

and technical data review. All stakeholders, including the pilots, are members of these bodies.

TRAINING FOR A LIFETIME

Forming a professional pilot requires not only training certain technical and non-technical skills, but also providing ongoing education in developing and maintaining airmanship skills.

“Pilot professionalism = training (resulting in a good response structure) + education (resulting in good airmanship)”

This requires formal initial and recurrent education in airmanship skills as well as proper ongoing airline mentoring by well-qualified pilots. Training and obtaining certain flying skills (manual handling) alone does not make a professional pilot.

The key point is the need for on-going pilot improvement that spans a career. Individual training courses are components of a qualitative continuous improvement program for pilots that is constantly monitored and improved by a Training Management System (TMS) process. Pilots would benefit from life experience allowing them to have a developed skill set.

An important education/training objective for developing a professional pilot is to ensure that industry provides airline pilots with the opportunity to develop and maintain the necessary pilot competencies and proficiency in which they can safely operate their airplane in a complex and high threat environment. While proficiency can be described as the completion of the competency requirements, the aim of training professional pilots should extend well beyond this benchmark. The final objective for a professional pilot is a “safe, sustainable lifetime performance”.

NOT A “ONE SIZE FITS ALL” APPROACH – TAILORED TRAINING

It is important for any training program to provide both a standard training for every student (i.e. a goal to train to), and tailored training that is student specific.

No two students are the same. Their initial experience and skill levels may be different, as well as their individual ability to learn certain concepts and skills at different rates. An effective training program will provide the required flexibility to ensure each pilot's skill sets meet and exceed the required proficiency and fluency to safely operate in the complex airspace environment.

A tailored student-specific training curriculum is necessary to help each individual achieve a common standard. The curriculum should avoid the “one size fits all” approach and be flexible enough to allow a continuous evaluation of the training process. That same flexibility should enable students and instructors to adapt the content to ensure the goal is reached. Different training tools should be at the disposition of the student and the instructor such that they can use those tools that best suit their needs.

TRAINING INTERVALS

Recurrent training sessions should be provided for each pilot at least once every six months and ideally once every three months. Economic circumstances however are eroding the amount of training such that many airlines are now down to the legal minimum. Worrying as well is that not always the actual minimum amount of training nor the interval is specified in legislation. The legislation merely offers a list of training exercises a pilot has to go through and how long he remains current on them. This unfortunate trend runs counter to the ever increased complexity of both the airplanes and the operational environment. In order to keep pilots proficient, more training is actually necessary to cope with this increased complexity. Regardless of the total amount of time available for training and checking, it is clear that less checking and more training is needed.

There are various possibilities to optimise the available training hours:

- » Allow manoeuvre validation checking during training and operations: if the training accomplished in recurrent satisfies a company's needs, then less checking is required.
- » Validating exercises during training and operations can free up time during checking which can be used for training scenarios specific for the operator (e.g. if a pilot has performed many recent CATIII landings, he should not repeat these during training and checking as he is clearly proficient).
- » Similarly certain items that are considered non-critical to a carriers operation could also have different intervals.

Just as one size fits all is not possible due to each carrier's specific operations, the amount of training may also be individualised in the sense that it could take account of the individual pilot's experience, his pilot background and his abilities.

“ In a confidential environment, the time gained during checking can be invested for offering the possibility to practice manoeuvres/scenarios they consider beneficial to increase their confidence level”

Pilots should be allowed to have input into what they want to see during the free time of a simulator session. This could help in providing for remedial training in order to obtain the proper proficiency and by strengthening the piloting skills.

The pilot community is convinced that the amount of time dedicated to training has to be increased. Solutions to increase this training volume have been proposed.

Legislation has to allow for company specificities and individual pilot needs whilst keeping track of increasing demands (operational/technology/etc.) and guarantee a sufficient amount of recurrent training. In short the pilot adagio is:

“ MORE TRAINING requires LESS CHECKING ”

PROFICIENCY AND FLUENCY

A good training program will embrace the concept of proficiency (demonstrated ability) and fluency (ability to use in the “heat of battle”). Instead of settling for a pilot being “proficient” in certain critical manoeuvres, we must maintain a level of fluency. Here is the difference.

Proficiency may be attained after several repeats. Fluency is only attained after a manoeuvre can be properly completed after numerous repetitions, without error, over time. If the manoeuvre cannot be done properly after the passage of time, that pilot by definition is not “fluent” although they may be proficient after one or more repeats.

Let’s take an example of our everyday life: everyone remembers learning how to ride a bicycle. It took many attempts before successfully staying upright (although still wobbly in the beginning). The first time you could ride your bicycle alone was a wonderful moment but when you tried it some days later you had to go through a number of repeats before you got the hang of it again. This is proficiency. If today you haven’t ridden your bicycle in over a year, and you just jump on, you will ride off without having to think about balance. This is fluency.

This concept may seem cumbersome and an additional burden to training, but this is not necessarily the case. Fluency should only be applied to truly “critical” manoeuvres, and be non-procedural in nature (as long as the aircraft is returned to a proper state of control, even if the crew omitted or committed a procedural step, it is fluent). All

non-critical manoeuvres may continue to be trained to proficiency.

“We want pilots to be fluent in flying not just proficient”

Of course it has to be defined which manoeuvres are “critical”, and should thus be trained regularly, whilst non-critical manoeuvres may not be visited as often. Safety and training data from the TMS can provide information which will show which tasks are critical and which are not.

Fluency can and should be the training/evaluation standard for airline pilots for the small sub-set of “critical events” which can lead to catastrophic loss of control if unrecognised. Fluency can be attained by offering realistic training of such critical events in established training cycles, and offering enough repetitions for each pilot so they can demonstrate adequate recognition and recovery skills.

As stated above, during recurrent training, less checking and more training is desired. The emphasis must change from checking pilot skills to training pilot skills. Proficiency and Fluency are maintained by practice and repetition over time, not by checking. Pilots also know which skills they need to practice and should be allowed to have input into the use of free time of a simulator period during recurrent training to practice these skills.





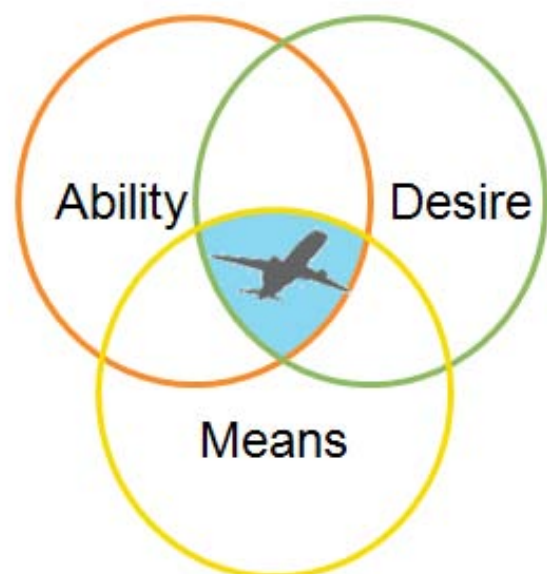
2. Selecting the right stuff

PREREQUISITES

So what kind of person would we ideally expect knocking on the door of a flight school? The candidate should be healthy, self motivated, have reasonable psychomotor skills and be emotionally stable. What we don't want is a candidate with enough money to eventually venture through flight training. Nor should any previous flight training be a prerequisite.

There are three characteristics we are looking for and all three have to be present in order for an individual to become a successful professional pilot: Desire, Ability, and Means.

One needs the desire or internal drive to want to fly and have the work ethic to develop the skills to become a pilot. The person also needs to have innate characteristics as well as the ability to learn. Finally they need the means (or opportunity) to obtain the pilot license.



Desire:

Pilot training is not easy. It is a big intellectual, physical and character building challenge. Throughout the training, the candidate will be faced constantly with new challenges and exams whilst being subject to an ever increasing complexity of the skills to be developed. And once the licence is received, training will not stop. Nor will taking exams. Throughout the flying career, the pilot will be continuously screened and will regularly have to demonstrate his/her skills to an examiner. Not always will the pilot receive class room training before taking an exam. So self-tuition will have to be a quality that the pilot possesses as well. Only candidates with enough self motivation to carry him/her through such a lengthy training process will succeed.

Ability:

For the very same reasons, emotional stability that comes with the ability for realistic self reflection is essential. When one starts learning to fly in a multi-crew environment, (s)he must possess people management skills in order to function properly as member of a crew. A clear set of values and rules is part of a stable character. Being able to make decisions without supervisions, in other words have enough self confidence, is important as well. The ultimate goal is to become a captain, this calls for leadership qualities and the ability to steer a team. The candidate should thus be an excellent communicator who from the first days of his flying career uses his naturally enquiring mind and his creativity to function properly in a team.

The candidate should already have received an education that has given him/her the ability to master English in a reasonable level as well as mathematics and physics. An academic qualification is not a necessity but rather a (valuable) personal educational bonus. Of course some sort of test will determine if these academic qualities are present at a level which is adequate to start ground school. As flying means also absorbing information in large quantities, the candidates need to be able to observe and process this data with accuracy and speed and make correct decisions that result in the appropriate action.

Good coordination skills should already be present in the candidate. One of the first things to learn will be the relation between speed, height and engine power and how the throttle, stick and rudder influence all those parameters at the same time. And the real challenge is to continue thinking whilst learning to move in three dimensions. Add on top of that the time dimension and you know that only those with above average psychomotor skills can succeed.

Obtaining a pilot licence is only possible if you are deemed medically fit. Medical tests will have to be passed and only when achieving a Medical Class 1 certificate, the candidate may fly commercial services. Candidates must be screened to ensure they can obtain this Medical Class 1 certificate and being healthy is thus a necessary precondition. Next to the medical condition there are of course basic physical requirements (like height) which are determined due to the cockpit designs.

The above list is of course non-exhaustive. Other dimensions that are considered to be crucial are a certain level of “common sense”, creativity and flexibility.



Means:

Everyone knows that pilot training is expensive. Those who don't have access to the necessary capital will feel the burden of heavy loans long after they receive their license. Those who are not granted loans can not even start flight school. And this is not acceptable. Personal wealth or access to money should not be a criterion for entering the pilot profession as it reduces the pool of candidate pilots.

SELECTION PROCESS

Now that we have established the prerequisites, we can look at the selection process. An evaluation will be necessary to check the level of the students when they start. Not only to filter out the right candidates but also to identify which areas the candidate has to focus on more during training. The main objective should be that this process determines with a good level of confidence if training can be concluded successfully. At the same time a longer term objective of identifying a reasonable potential for lifetime performance, should always be kept in mind. These are no easy tasks and the question begs who will be able to run such a selection process and how.



***“ Who better than a pilot to recognise
the seeds of necessary skills in
candidate pilots? ”***

The final decision on who to select has to rest with the pilots involved in the decision process and with pilots being part of the decision loop and the involvement of initial and advanced trainers, the TMS process would have the highest chance of selecting the right candidates. The instructor role would be instrumental in the selection process as they could provide the necessary feedback on how previous candidates have fared during training. This feedback should help refining the selection process. Such a validation of the selection criteria is important to ensure a continuous improvement of the process quality. As generations develop and come in with their own qualities and deficiencies, the prerequisites, the desired pilot profile and the training itself will also develop over time.



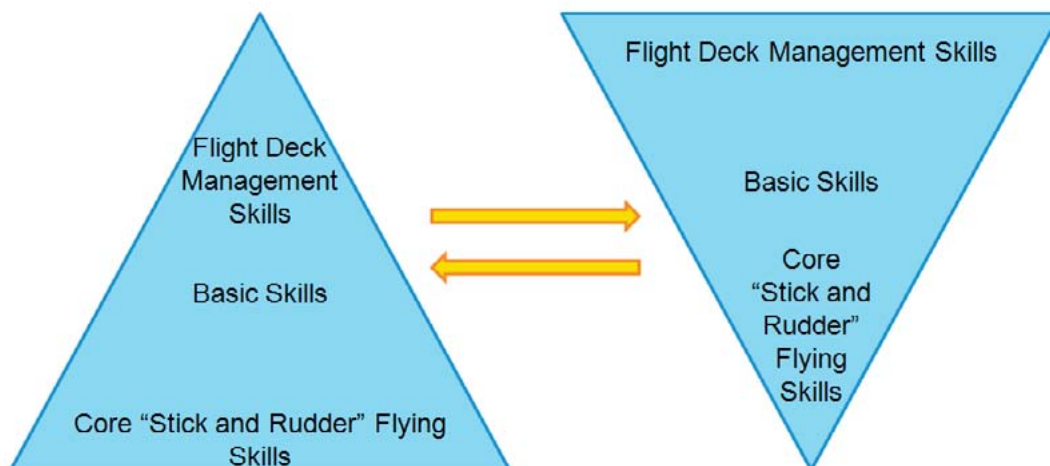
3. Skills & Competencies

Selecting the right individuals for pilot candidates is an important step to ensure success in developing a professional pilot. The previous chapter looked into the qualities desired in a candidate and how to select the future pilots. The next step is to define what skills and competencies must be trained.

Let's return to the key principle that we described in the chapter Fundamental concepts: the paradigm shift. We explained the two triangles that both consist of the same skills: core stick and rudder skills, basic skills, and flight deck management skills.

PSYCHOMOTOR SKILLS AND COMPETENCIES

Although the daily routine of flying is driven by automation, the laws of physics haven't changed. Basic flying skills need to be trained to build a strong fundament that every pilot can fall back to when necessary.



Both triangles however show that the emphasis on what skill set is mostly used can be different depending on the situation. This reversal in priorities and the shifting from one to another depends on whether one is in a normal or abnormal situation, the aircraft generation and complexity, the pilot's technical skills, the pilot's fluency, etc.

So what skills and competencies do we need to train to allow pilots to master this paradigm shift?

Because when all else fails, the pilot is the one that will fly the airplane manually. Once on the line, the amount of hand flying is very low. This makes it even more important to develop strong basic flying skills early on in the training.

The psychomotor qualities will build on the coordination skills that were one of the prerequisites in pilot selection. Operating in a 3D environment relies on basic core flying skills and highly

developed hand-eye coordination. How do we build these hand flying skills and upset recovery techniques?

A variety of possibilities exists and a training program should use all of them:

- » a certain amount of [glider training](#) early on in the training will help candidates in performing coordinated turns, grow respect for the risk of stalls and spins, and will make them acquainted with high bank angles
- » [aerobatic training](#) will improve their confidence in recovering from upset situations and have them experience unusual attitudes
- » [much more emphasis on visual flying](#) (without instruments) will build the skills to become a pilot who is more at ease when vital flight instruments fail
- » and most importantly: candidates should not progress too fast to the next stage in training. [Acquiring good basic flying skills takes time](#), but it can be done in relatively cheap aircraft (compared to the aircraft and simulators used later in the training program). The benefits are large: having the basics right might even increase the success rate of the candidates or reduce the training amount later on in the program.

The outcome of such an exhaustive basic training of the basic flying skills will result in pilots being more confident in their ability to hand-fly the airplane and to escape from upset situations. It will make the pilots fluent in basic hand flying. That has always been and still is today the basis of the pilot profession.

SOCIAL SKILLS & COMPETENCIES

Since the needs and demands for professional pilots do incorporate a lot more than the basic flying skills, additional skills and competencies need to be taken care of. Relying solely on a pilot's technical knowledge and skills is not sufficient to safely operate complex





aircraft in today's flying environment. Just as important as technical skills, is to recognise the need to train the so-called non-technical skills. Both positive and negative outcomes of many incidents and accidents in the aviation industry are directly traced to critical non-technical skills. Non-technical skills have their place in all pilot training courses, be it initial training, recurrent training, requalification or initial operating experience. They deal with fuzzy and thus difficult to quantify concepts like: motivation, social interaction, leadership and followership, common sense and logic, and communication skills.

Crew Resource Management (CRM)

Flying commercial operations is not a one man show. Flight crews consist of two or more members. Adequate crew coordination and teamwork is thus crucial for providing a safe operational environment. How does one operate best in a team? How to divide the tasks amongst crew members (pilot flying/pilot monitoring and multitasking versus delegating)? How to deal with conflict resolution? How to communicate, how to make decisions in a team? Originally portrayed as a conflict resolution skill, CRM has evolved over time to address all these questions and has become a set of skills to support a pilot's technical and decision-making flying skills. CRM is a safety barrier against human error by managing resources within the flight crew team.

CRM has shown its merits and it has become "best practice" to fully integrate CRM training into initial licensing and recurrent training programs. The principles of CRM are essential tools that pilots need to learn and continually improve. Pilots cannot master these skills by attending a one-time course. A high level of proficiency in CRM requires continuous training, evaluation, and feedback.

Safety depends on the coordination of key people in the entire system and not just on the actions of pilots. When CRM training is given in the framework of an operator it would be beneficial to involve all safety personnel in the course. Together flight crews, cabin

crews, and dispatchers can improve the level of understanding and cooperation across the entire team.

Special attention has to be given during the upgrade to captain on how to deal with leadership. A captain has extra responsibilities and duties. The way he exercises his authority is very important for the working relationship with the crew and thus forms an integral part of CRM.

Threat and Error Management (TEM)

One of the underlying principles of Threat and Error management is the premise that human error is inevitable. So threats can popup at any time during operations even though their cause may be much earlier in the system (human error is omnipresent: not only in the daily operations but also in the design, construction, operations, and maintenance). Identifying a potential threat is an important competency for a pilot. Once identified, the chain of events can be broken so the error does not propagate through the system and escalates. Only pilots, who understand the limitations of human performance and are trained to develop skills to detect and manage these errors, will be able to do so.

Decision Making

If there is one constant during flying it is decision making. From the start of the duty to the moment that the pilot disembarks, (s) he has been making decisions continuously. Decision making is also an integral part of CRM and TEM. Effective decision making is critical to safe operations. It is also embedded in the paradigm shift. It relies on the change of the mental status from a normal to an abnormal situation and from a monitoring role to an active role.

Airmanship Development

Pilot professionalism can only be created by combining a thorough education resulting in airmanship with a constant development throughout the entire career of a professional pilot. Creating a professional pilot requires not only training competency in certain technical and non-technical skills, but also requires on-going education to

aid pilots in developing and maintaining airmanship skills. This requires formal initial and recurrent education in airmanship skills as well as proper on-going airline mentoring by well-qualified pilots.

Information Management

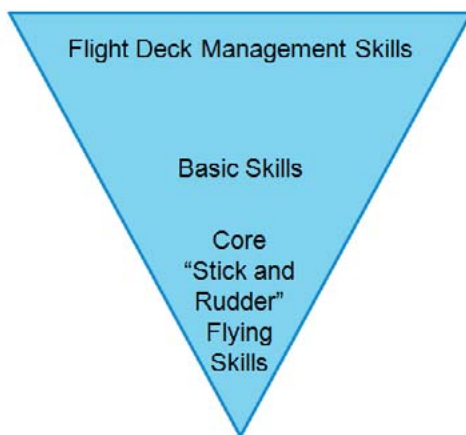
Systems that provide information in the cockpit have improved pilot situational awareness and increased safety. However, if the interpretation of the information is problematic or too much information is provided, the same systems can also have serious negative effects on safety. The design of systems that provide information should take into account the concept of human factors: how will pilots deal with the information presented and will this result in the action that is wanted? On the other hand of the scale, pilots need to be taught how to deal with the information presented. Pilots need to learn to apply their knowledge to be able to prioritise the information available. Training pilots in this art is a precursor for good information management.

Pilot Monitoring Skills

Part of the learning curve is to make candidates aware of the importance of the function of pilot monitoring (PM). The PM is the one who has the big picture. The PM is the thinker who is aware of the full scale of the situation. This role is typically requiring the use of the upside down triangle of the paradigm shift.

Automation Management

Because automated systems have become very reliable, the risk exists that pilots may become complacent and rely too much on the automation. Usually the data that is cross-checked is correct and most flights are routine. The work can become very procedural. It can be difficult to identify when automation starts to deviate from what is expected. The challenge for the pilot is to understand at all times what the automation is doing, why it is doing it and if what it is doing is what the pilot expected. In brief the pilot should always have a good situational awareness.



This will allow using the maximum potential and effectiveness of the automation technologies and the flight crew.

“The ultimate goal is to develop a ‘3 pilot’ operation consisting of the two pilots and the automation”

Workload Management

When working in a team, the team leader is responsible for prioritising the work and distributing the workload amongst the crew. The captain needs to be trained in properly assessing the workload, the pace and the prioritisation. All crew members need to be aware of their own workload and advise other crew members if they are getting overloaded. The key to workload management is not only knowing what to do but also when to do it.

Time Management

“Time” can quickly slip away from pilots. Time means speed and speed means acceleration. Acceleration (through an increased workload) can lead to a lack of perception. The faster we go, the less time we have to identify threats and errors ahead of time and prevent them. If time is slipping away from the pilot, the pilot needs to defuse the situation. This means (s)he first must be



able to recognise the time acceleration, then slow things down, do a re-evaluation and take control of the situation.

Effective time management is an important skill that every pilot has to learn. Training programs need to train pilots on how to manage time both in normal and non-normal operations. During training, pilots have to be taught to stay ahead of the airplane. This requires good planning skills and anticipation of what will happen, including anticipating possible threats and errors that might develop.

Culture

The aviation language is English, but as this is not the mother tongue of all aviation professionals there are two caveats that need to be taken into account.

Firstly, flight crews should all be fluent enough in English. This does not only mean being able to speak and understand the standard phraseology. If one has to function in a team, the English proficiency needs to be high enough. Secondly, the way people express themselves is different based on their own cultural background even when they all speak English. Cultural differences need to be understood and respected in order to provide for a positive and safe working environment in the cockpit, in the cabin and within a company.

Professional development

Ideally a pilot should strive to continuously grow his/her professionalism.

“This is not something that can be taught, it must be learnt”

Having peers in the company who provide good leadership and serve as a role model could help newly hired pilots. An effective briefing and debriefing forms a vital part of building professionalism. The newly hired pilots of course should be open to such mentoring and a good dose of self critique will also help them evolving.

Fatigue and stress management

Stress can have many different causes. It can be related to a challenging flight due to weather constraints resulting in a difficult approach. It can be related to a very high workload.

Fatigue is another factor that can make a flight duty very challenging. Again the causes can be multiple and be either personal or professional. For pilots it is important that they can recognise the signs of fatigue and stress and that they know how to manage it. They should also conduct a self assessment before every flight duty and ask themselves: am I fit for duty?

Passenger interaction

Pilots' responsibilities go far beyond flying the airplane from A to B. At the same time he is the representative of the company, he has to do the public relations and show salesmanship. When faced with delays and cancellations, the way the pilot communicates with the passengers and the decisions he takes will make the difference between customers being satisfied or not with the service provided. Acquiring such qualities requires a specific training.

The pilot can also be faced with less pleasant events like unruly passengers and injuries, illness or death of passengers on board. Also for these tragic cases (s)he should have received the necessary tools during training to cope with these situations when they occur.



ACADEMIC

As explained in chapter Prerequisites (p. 12), it is important that the candidate pilot has some basic academic skills (mathematics, physics, English proficiency) without needing a specific academic qualification. The important thing is that the candidate has the mental ability to learn, comprehend and understand. The academic part of the pilot training will further expand the knowledge base of the candidate on several levels (like for example understanding technology but also human factors) and teach how to use logic thinking.

Not only learning is important, the acquired knowledge should also be retained long after the exam has been passed.

In the keynote we mentioned Lilienthal, the Wright brothers and the fact that the basic principles of flight are still valid today. So a thorough theoretical and background knowledge of principles of flight, aviation and aircraft systems, as well as human interaction and management principles are a cornerstone of a successful pilot career. In order to master flying, to live and breathe aviation, it is worthwhile to also educate candidates in subjects like aviation history.

A basic level of education should include:

- » Medical
- » ATC issues
- » Aviation history
- » Weight and balance
- » Navigation
- » Regulations
- » Theory of flight
- » Meteorology
- » Aircraft systems
- » Performance
- » SMS

MEDICAL

In the previous chapters on Prerequisites (p. 12) and Social skills and competencies (p. 16) we discussed about basic need to qualify for a Medical Class 1 certificate, and to have some basic physical requirements, emotional stability and stress management.

By definition many of these can not be trained, but some can be strengthened during training. People characters are formed, mental endurance is strengthened and candidates learn how to cope with stress. There is no specific training for any of these, but the whole training experience will help improve them.

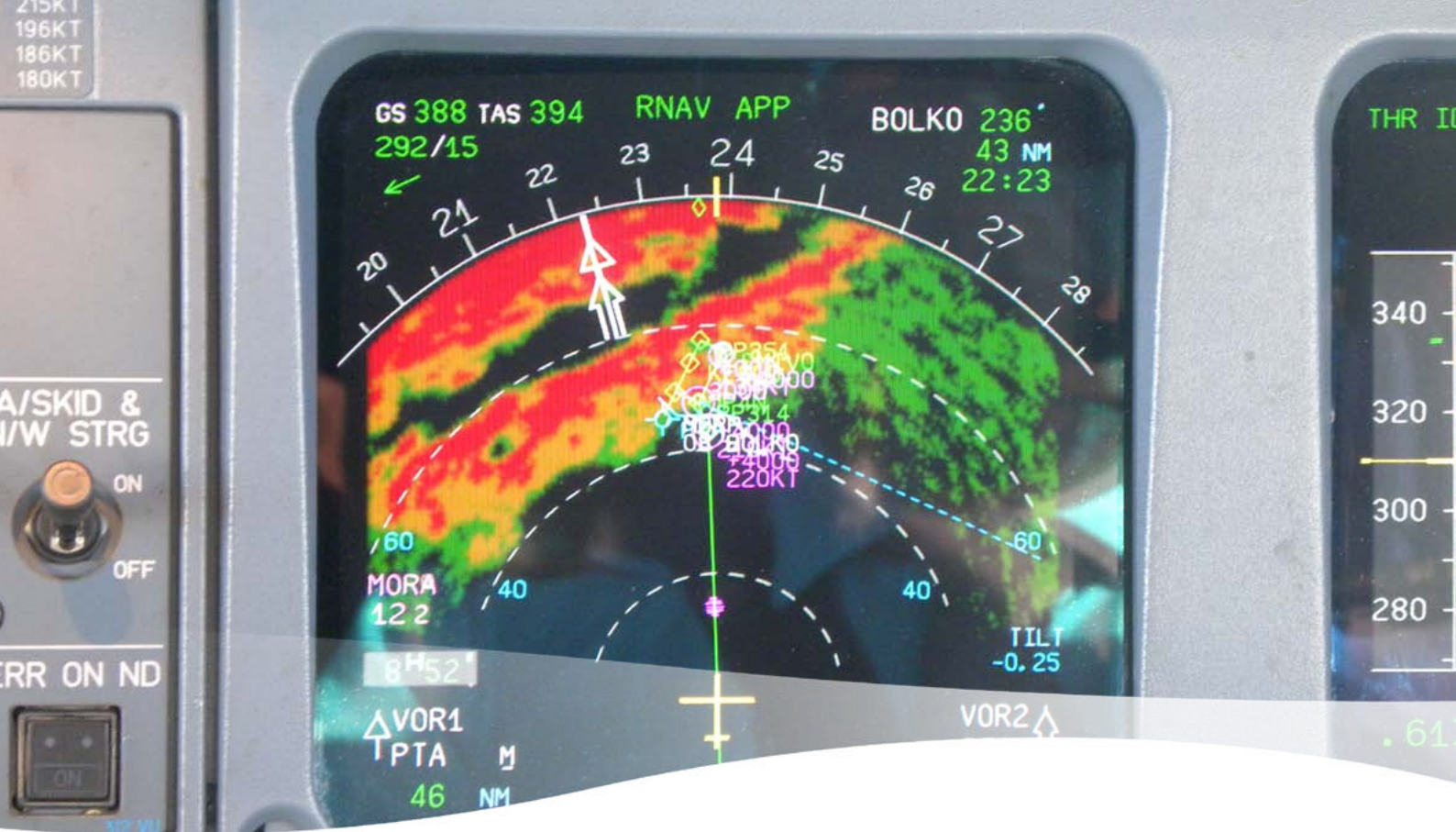
4. Career path



Throughout a pilot's career the aviation world may change in so many aspects that it also affects his/her day-to-day work. The nature of the operations may change, pilot responsibilities may change, new technology is introduced, new airplanes are introduced. All of this has its own impact on the profession. And all of the time the pilot needs to stay proficient and fluent. This is an enormous challenge that requires career long studying, training and exams. Mentoring programs may help in this continuous learning process. Mentoring refers to a personal development relationship in which a more experienced pilot helps a less experienced pilot develop the skills necessary to accomplish a task in an efficient and safe manner. Mentoring plays a key role in fostering and teaching non-technical skills and must continue through a pilot's career.

Operators and pilot representatives should work together in the development of formal mentoring programs such as "buddy pilot programs".

These mentors are best sourced amongst experienced pilots who know the operators' culture. They are also very suited to run a leadership and command training. The purpose is to ensure that the pilot possesses the full package of skills, geared towards the specific nature of the operations.



The 'who' & 'how' of training

The better the environment in which training takes place, the higher the training quality and output will be. Especially for ab initio training an academy style that allows students to live, eat, and breathe flying, will reap high benefits. In this type of environment a student is not only free of distractions but also able to profit from a peer support network. "Hangar flying", a concept where instructors, pilots and students spend free time together talking about their experiences in flying, brings tangible training benefit.

When first entering a flying school, the students will be evaluated. The recognition of prior learning can help tailor the training program to their specific needs. The start level however should be sufficiently high and related to the end goal. As mentioned earlier, it is not an easy road to achieve a pilot licence. Students may enter flying schools with different motivations which can for example be the pure wish of flying, or an

attraction by the technology. Whatever the motivation is, the level must be high enough to achieve the final goal: become a pilot. The instructors have to help the students to keep the level of motivation throughout the training. Having tailor-made programs that help the student in those areas where needed most, can be a good tool for this. Equally, we do not all learn in the same way: some benefit from a classroom environment, others do not. In order to achieve the highest benefit for the student, it could be useful to use those devices or programs best suited to his/her personality: be it for example classroom training, or computer based.

A good, open, friendly and direct relationship between student and instructors is elemental. The instructors should install confidence in their relationship with the students. Throughout the training, this confidence will be transferred to the student as (s)he will feel the improvement in his/her achievements.

Throughout the training, there has to be a continuous evaluation of both the program and the student.

“This feedback will help streamline the next steps in training and improve the training program for future students”

But also the instructor shall be continuously evaluated. Everything stands or falls with the quality of the instructor. Only the best of the best should train students. Different subjects of course need different trainers: a classroom lesson on aviation history does not call for the same instructor competencies as teaching some basic aerobatics. Both qualities may be present in one person, but not necessarily.

1. Training delivery methods

The aim again is for pilots to become and remain proficient and fluent. A tailored delivery of training can help and this includes the possibility to choose the best suited training method. There are many training delivery methods available in preparing today's flight crews to perform their jobs safely and professionally.

For some elements of training more than one training practice could be beneficial. But one should not always get to choose: there are some elements of training that clearly must be undertaken in the proper training device to produce the most optimal outcome. The use of some devices is even mandated by regulatory requirements.

Whatever device is used, it must be ensured that there is consistency in the analysis and assessment method, so that the expected outcome is standardised. If the necessary standard is not met at the end of the training, remedial training has to be put in place to solve the deficiency.

Irrespective of the training method, a great deal of self tuition is expected from the pilots. This will remain so throughout the pilot career.

Immersion Environment

Of all the environments that are available to learn how to fly, the immersion environment (flight academy style) is optimal. The

advantages of being surrounded by other airmen going through the same experience are invaluable. Without the external distractions of the outside world, the immersion environment allows the developing pilot to live, eat, and breathe flying. Interaction with fellow trainees, like “hangar flying”, in an environment outside of the classroom is extremely helpful for a pilot in training. The student gets to absorb information and share experiences with his peers. This helps to accelerate the learning process and allows the candidate pilot to complement his/her learning. This type of environment could be applied to all phases of training: ab initio, type rating, and recurrent training.

Chair Flying Technique

This technique allows the candidate pilot to practice his thought processes, develop cockpit flows, and mentally go through different manoeuvres. It is a very inexpensive and rewarding method of self teaching and can be easily done in a quiet room with a poster or picture of the cockpit, and a chair. Some training facilities may provide mock-up cockpits for their students to utilise for this purpose. Mentally preparing for the next day's flying or simulator session using this method is invaluable. It is also an excellent way to mentally go through the previous lesson. Training programs should encourage this practice and stimulate students to use this method as often as they can.

Briefing/Debriefing

The benefits of a proper briefing and debriefing cannot be emphasised enough. The candidate pilot must know what is to be expected of his/her performance and be able to ask questions prior to each training event. After the training, a concise debrief on the training pilot's performance, both positives and negatives, with explanations of ways to improve are essential. An instructor must thus be a good observer and a good listener to provide proper feedback to the student. Briefings should never be rushed. Enough time has to be available to allow for both a good understanding of the task ahead, and for the evaluation.

Observation flights

Observation is a very valuable cost efficient method of learning. During ab initio training, being an observer during flight training of other students is very satisfactory and improves the learning curve. It offers a perfect real time situation where the jumpseater can observe the performance of the crew flying and learn how they handled operational issues and work as a team. Pilots going through training should be encouraged to volunteer riding the jumpseat for this purpose. By definition observation flights also provide a tremendous amount of pilot monitoring training.

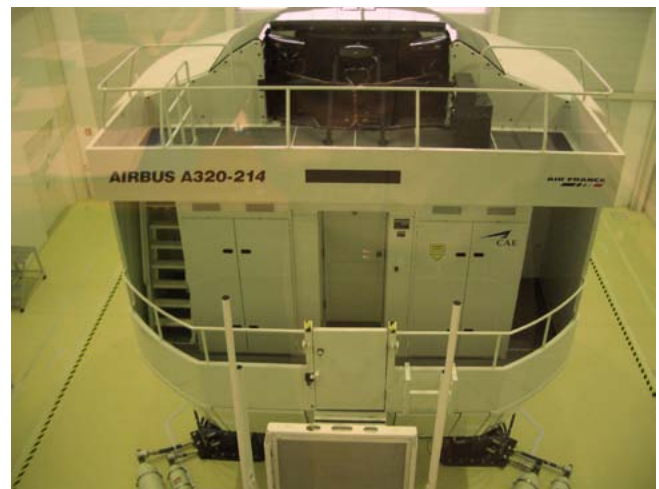
Scenario Based Training

The purpose of scenario-based training is to emphasise the development of critical thinking, flight management and flying skills during normal line operations. This is very different from the traditional manoeuvre-based skill training.

The goal of scenario-based training in a full motion simulator is to accelerate the acquisition of higher-level decision-making skills and airmanship by requiring the pilots to apply their entire acquired training knowledge and skill sets during Line Oriented Flight Training (LOFT). Scenario-based training would normally be used during later stages of a type-training course and during recurrent training.

Training programs should include scenarios from accident, incident, and safety data gathered under the TMS, to provide realistic opportunities for pilots to see how threat situations may develop and how they should be managed during line operations. This facilitates pilot evaluation of real world events and teaches appropriate pilot responses to line-oriented situations.

Pilots would not normally be briefed ahead of time that they are receiving scenario-based training or what events are going to happen. The concept is to put the pilots into line oriented flying which contains



unexpected threats or events and allow the pilots to recognise and manage the threats or critical events as they develop during normal operations.

Media based instruction

There are several methods for delivering training and it is important to choose the one that fits the task and the student best. Media does have its place in certain aspects of pilot training. Presenting pure information is often best done through media - it can then be repeated or stopped as many times as necessary to maximise comprehension. It can be done at the discretion of the student, in almost any location, and relatively inexpensively.

It is equally as important to know the limitations of training with media. Providing

the opportunity to ask questions or clear up misunderstandings with an instructor has to be complementary to the use of media-based training.

Computer Based Training or Distance Learning Education

This comes in different forms directly to a pilot's designated company mailbox, to his email account, or is downloaded directly from a company internet site. Generally, it should be clear information that will not generate unanswered questions for the pilot, otherwise there is a risk of negative training. This is a method which can save on classroom time and can be useful for a pilot to refresh his/her knowledge. However adequate time to address questions must be allocated during a training cycle.

Classroom

Early on in a pilot training program, the classroom environment is an integral part of the education process. In the ab initio phase the classroom environment is crucial to answering questions and to transfer knowledge and techniques from

the instructor to student. As a pilot career progresses, the balance between classroom and media based training changes. At many operators, classroom time has been severely curtailed or eliminated and replaced by Computer Based Training. Care should be taken however that safety critical information can be dealt with adequately and that opportunity remains to have this being briefed directly with the pilot.

Startle factor

A startle or surprise arises when a mismatch occurs between the pilot's mental expectation model and the real events. Pilots must think "outside the box", in other words, be trained in non-linear, unpredictable and undefined events. This can be achieved by introducing a 'startle factor' in training.

The role of instructors in a pilot career is crucial towards the development of all the skills and competencies. A good, open, friendly and direct relationship between student and instructors is fundamental. The instructors should install confidence in their relationship with the students. Throughout the training, this confidence will be transferred to the student as (s)he will feel the improvement in his/her achievements.

2. Instruction cadre

Therefore it is absolutely essential that any instructor is well aware about his/her duties: help, the student to develop the required skills and competencies. An outstanding instructor is "allowing" a student to develop the required self consciousness and self-reflective skills that are needed for a pilot's stable and successful lifetime performance. The better the instructors, the better the trainees, the faster the training, the cheaper the training and the higher the benefit throughout the pilot career. So instructors have to be both experienced and very well trained. The better trained they are themselves, the better the training

they can give. Instructors who only have a minimum number of flight hours may lack that additional experience acquired during a longer career. Ideally instructors should be pooled from experienced pilots who have the flair and the human skills to educate.

As explained above, training different subjects calls for different competencies. A classroom course on aviation law, SMS or the physics of flight, require a different skill set than a glider instructor. Both skill sets may be present in the same person but that is not necessarily the case.



Conclusion

Flying has been man's oldest dream. Still today it inspires. Children look up when hearing an airplane overhead. And they dream about being at the controls.

In a "Pilot Training Compass: Back to the future" we have explained the challenges that candidate pilots face. From the economic challenges of the industry, to the complexity that automation brings, becoming a pilot is so much more than acquiring stick-and-rudder skills. The paradigm shift is one of the key concepts we have explained. Being able to switch to that skill set, quickly and swiftly, required by the circumstances is a competence that has to be embedded in every pilot.

We also introduced the concept of a Training Management System, which will help implement and improve training programs by involving all stakeholders, including pilots. It all starts by selecting the right candidate pilots. Pilots can be a good addition to such a selection process because who better than a pilot to recognise the seeds of piloting skills in candidates? Teaching should be done by only the best. The quality of the instructors

will largely determine the success of any training program. Mentoring programs should be set up throughout the pilot career to help pilots learn from their experienced peers. They will learn from their professionalism because professionalism cannot be taught; only learnt. An early investment in good basic flying skills will lay a fundament where the pilot can rely upon for the rest of his flying career. Becoming fluent in critical manoeuvres rather than proficient is the goal. During the career, more time needs to be devoted to training, and less to checking. Checking does not make a pilot proficient or fluent, training will. Continuously cutting back in training programs therefore is not a good idea.

We hope that this report "Pilot training compass: Back to the future" will help discussions and ultimately improve the quality of pilot training. From the first knock on the door of a flight school to the day of retirement, pilots will continuously be trained and evaluated with one final objective in mind: ensure a safe, sustainable lifetime performance.

ABOUT ECA

The European Cockpit Association (ECA) was created in 1991 and is the representative body of European pilots at European Union (EU) level. It represents over 38,000 European pilots from the National pilot Associations in 37 European states.

European Cockpit Association AISBL – Piloting Safety
Rue du Commerce 20-22 / B-1000 Brussels

eca@eurocockpit.be
www.eurocockpit.be

T +32 (0) 2 705 32 93
F +32 (0) 2 705 08 77

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