LUND UNIVERSITY
School of Aviation

# The Multi Crew Pilot Licence
# - Revolution, Evolution
# or not even a Solution?

*- A Review and Analysis*
*of the Emergence, Current Situation and Future*
*of the Multi-Crew Pilot Licence (MPL)*

*Rickard Wikander and Dr. Nicklas Dahlström*

# 1. ABSTRACT

This study is a review and analysis of the Multi-Crew Pilot License (MPL), which was introduced by the International Civil Aviation Organisation in 2006 as an alternative to traditional pilot training. The emergence of MPL was based on industry consensus that existing pilot training had reached its limits and this led to the review and revision of an almost 70 year old pilot training legacy.

The MPL allows for a new training methodology called Competency-Based Training (CBT) in which achievement of specific competencies rather than the accumulation of training time is the primary target and unit of measurement. The MPL includes more training in different types of Flight Simulation Training Devices (FSTDs) in preference of flying time in aircraft – an aspect which has become intensively discussed. This study focuses on the background that the MPL arose from, how its implementation and progression have proceeded, if the MPL experience means that vital aspects of pilot training have been improved or lost, and what the global status of the MPL is today. The study has also reviewed the main concepts and building blocks of the new license, primarily the above mentioned CBT and the increased use of FSTDs.

By using openly available information, the current MPL literature and research has been retrieved and analysed. In addition, the authors have attended aviation training conferences to get access to industry information directly from the training providers who are currently performing MPL training. To these sources of information, interviews and personal conversations with industry stakeholders have been added to provide a more in-depth perspective, as well as feedback and comments on certain aspects of the MPL.

The MPL experienced an initial slow rate of adoption and acceptance, but more recent data shows that the concept has steadily continued its expansion, especially in Asia and the Middle East. However, this study has revealed that the transfer from the traditional task-based training approach to the new and different competency-based approach is not an easy challenge. It is in fact questionable if any MPL training provider actually yet successfully has accomplished this feat. The authors believe that this is not the case, as the practices of existing regulation does not facilitate or even allow for this transfer of training focus to be fully implemented. Also, the seven years that has passed seems to probably not have been enough for flight training organisations to complete this transition.

There is however at this point in time no indication that the MPL should have any significant shortcomings in comparison with traditional airline pilot training, although some training challenges of the MPL have been identified and these will need to be managed. The airlines involved in MPL training are surprisingly uniform in being positive to the new training regime even though the full potential of it has yet to be explored and put into practice. A more problematic aspect is that that regulators are locally changing and adapting the intentions of CBT, causing a global harmonisation in training standards, especially for the MPL, to quickly move out of reach. Also, it is clear that financial perspectives in the industry will also play a part in how the MPL will continue to evolve.

The report is summarised with recommendations to current training providers interested in using the results of this study to improve their MPL training. These recommendations should also be of interest to regulators, industry specialists and everyone else involved in the further development of the MPL.

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## 2. GLOSSARY OF ACRONYMS

| | |
|---|---|
| AABI | Aviation Accreditation Board International |
| AELT | Aviation English Language Training |
| ALPA | Air Line Pilots Association |
| AMC | Acceptable Means of Compliance |
| ANB | Air Navigation Bureau |
| ANC | Air Navigation Commission |
| ANZSASI | Australian & New Zealand Societies of Air Safety Investigators |
| APATS | Asia Pacific Airline Training Symposium |
| APIC | Airbus Pilot Instructor Course |
| AQP | Advanced Qualification Program |
| ASEAN | Association of Southeast Asian Nations |
| ATC | Air Traffic Control |
| ATO | Approved Training Organisation |
| ATPL | Airline Transport Pilot License |
| BITD | Basic Instrument Training Device |
| CAA | Civil Aviation Authority |
| CAAC | Civil Aviation Administration of China |
| CAFUC | Civil Aviation Flight University of China |
| CAPA | Center Air Pilot Academy |
| CASA | Civil Aviation Safety Authority (Australia) |
| CBE | Competency-Based Education |
| CBT | Competency-Based Training |
| CFIT | Controlled Flight Into Terrain |
| CPL | Commercial Pilot License |
| CPTP | Civilian Pilot Training Program |
| CRM | Crew Resource Management |
| EASA | European Aviation Safety Agency |
| EBT | Evidence-Based Training |
| ECA | European Cockpit Association |
| EFIS | Electronic Flight Information System (alt. Electronic Flight Instrument System) |
| ETOPS | Extended-range Twin-engine Operations Performance Standards |
| FAA | Federal Aviation Authority |
| FAI | Federation Aeronautique Internationale (The World Air Sports Federation) |
| FCLTP | Flight Crew Licensing and Training Panel |
| FMS | Flight Management System |
| FI | Flight Instructor |
| FNPT | Flight and Navigation Procedures Trainer |
| FPI | FlightPath International |
| FSTD | Flight Simulation Training Device |
| FTD | Flight Training Device |
| FTO | Flight Training Organisation |
| GCAA | General Civil Aviation Authority (United Arab Emirates) |

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|---|---|
| HKCAD | Civil Aviation Department Hong Kong |
| IAAPS | International Association of Aviation Personnel Schools |
| IAFTP | International Association of Flight Training Professionals |
| IATA | International Air Transport Association |
| ICAN | International Commission for Air Navigation |
| ICAO | International Civil Aviation Organisation |
| ICFQ | International Committee for FSTD Qualification |
| IFALPA | International Federation of Airline Pilots' Association |
| IFR | Instrument Flight Rules |
| IOE | Initial Operating Experience |
| IPPTG | International Professional Pilots Training Group |
| IPTS | IFALPA Pilot Training Standards |
| IR (A) | Instrument Rating (Airplane) |
| IRI | Instrument Rating Instructor |
| ISD | Instructional Systems Design / Instructional Systems Development |
| ITQI | IATA Training and Qualification Initiative |
| IWG | International Working Group |
| JAA | Joint Aviation Authorities |
| JARs | Joint Aviation Requirements |
| JAR-FCL | Joint Aviation Requirements – Flight Crew Licensing |
| JOC | Jet Orientation Course |
| KSAs | Knowledge, Skills and Attitudes |
| LFT | Lufthansa Flight Training |
| LIFUS | Line Flying Under Supervision |
| LOCI | Loss of Control In-Flight |
| LOSA | Line Operations Safety Audit |
| LT | Line Training |
| MCC | Multi-Crew Cooperation |
| MCCI | Multi-Crew Cooperation Instructor |
| ME | Multi- Engine |
| MPL | Multi-Crew Pilot License |
| MPLI | Multi-Crew Pilot License Instructor |
| NAA | National Aviation Authority |
| NATA | National Air Transport Association |
| NATS | North American Transportations Statistics |
| NGAP | Next Generation of Aviation Professionals |
| NPRM | Notice of Proposed Rulemaking |
| OEM | Original Equipment Manufacturer |
| OM | Operations Manual |
| PABC | Professional Aviation Board of Certification |
| PANS | Procedures for Air Navigation Services |
| PANS TRG | Procedures for Air Navigation Services - Training |
| PELTP | Personnel Licensing and Training Panel |
| PF/PNF | Pilot Flying/Pilot Not Flying |

| | |
|---|---|
| PICAO | Provisional International Civil Aviation Organisation |
| PIC | Pilot-In-Command |
| PICUS | Pilot-In-Command Under Supervision |
| PPL | Private Pilot License |
| RAA | Regional Airline Association |
| RAeS | Royal Aeronautical Society |
| RPKs | Revenue Passenger Kilometres |
| SARPs | Standards and Recommended Practices |
| SAT | Systems Approach to Training |
| SCAA | Swedish Civil Aviation Authority |
| SFI | Simulator Flight Instructor |
| SOP | Standard Operating Procedure |
| SR | Speech Recognition |
| STI | Synthetic Training Instructor |
| SUPPs | Regional Supplementary Procedures |
| TC | Transport Canada |
| TCAS | Traffic Collision Avoidance System |
| TEM | Threat and Error Management |
| TER | Transfer Effectiveness Ratio |
| TGL | Touch and Go Landing |
| TOT | Transfer of Training |
| TRE | Type Rating Examiner |
| TRI | Type Rating Instructor |
| UAA | University Aviation Association |
| VFR | Visual Flight Rules |
| WTS | War Training Service |

# 3. INTRODUCTION

The word "*alternative*" has strongly been associated with the MPL since before its emergence. This has been used to label the MPL as an *alternative* method of training that incorporates *alternative* learning methods and implies that it is something foreign, new and perhaps entirely unknown. It has also been clearly presented as an *alternative* to proven traditional training methods without the intention to replace them. However, the roots of the MPL are not founded in *"various philosophies that are fundamentally different from those of mainstream or traditional education"*, as the definition of *"alternative education"* or "*non-traditional education"* would suggest. The MPL has been developed on the back of current training standards and it is claimed to be based on "proven training standards", which makes the adversity towards what essentially has been "licensing re-design" confusing. This confusion has however highlighted the challenge of attempting to extract and explain what may be the most useful and relevant aspects of commercial pilot training.

Questions that have been raised are if this new approach means that vital aspects of training are lost and what background this attempt to modernise training arose from. This study is partly an attempt to evaluate an around 70 year old legacy of commercial pilot training; who has performed the training, where it has been performed and perhaps most importantly how it has been delivered – and this attempt has produced some conflicting results. Some of the results have been difficult to interpret and understand, e.g. flight instructors talking of job insecurity in a time where aviation industry prospects for pilot employment is improving or cadets stating that trying to figure out how to live up to the initial job requirements steal focus and interrupts training. This is a reality which raises the question if current methods really are the best to prepare and motivate both pilots and instructors. It seems at times as if flight training providers are busy preparing new pilots for a future in the industry that they themselves are uncertain on how it will play out.

The MPL has provided airlines with a flexibility which proved to be effective when linked with sponsorship programmes. It has provided an opportunity to combat concerns shared within the aviation industry, such as those of effective crew communication, teamwork and other crew resource management skills. It has required training to be founded on company SOPs and their CRM philosophies. Theoretically, training no longer needs to be over-engineered with add-ons, such as MCC, JOC, CRM and TEM, which all become obsolete when already integrated into the core of training. The MPL is not aimed at producing a generic, not-ready for direct airline entry pilot, but rather one that an airline can mould the way they see fit. Every level of the training is intended to be targeted towards the right-hand seat, with the cadet and instructor co-oriented towards this goal. As a result, the end product should be a pilot tuned to his airline, motivated by probable job security and competent to fulfil the role of his position. If this is what the MPL produces, however, remains to be answered. This report is a critical review of the building blocks that have become the MPL license as well as of the worldwide MPL experience so far, in an attempt to understand its strengths and weaknesses. The result can possibly provide guidance for the future development of the MPL and assess its true role in future pilot training together as well as in harmonising global training standards.

## 4. PURPOSE, METHODOLOGY AND LIMITATIONS

The primary purpose of this report is to meet the requirements for a bachelor thesis on the Lund University School Aviation combined MPL and Bachelor program. It is with this in mind that the topic and scope was originally conceived, discussed and planned. However, the topic turned out to be one of great interest not only for the student as well as the supervisor, but also for the organisation they were associated with, the local regulator and potentially for the aviation training industry, and thus the scope was widened and re-oriented towards a broader overview and review of the emergence, current situation and future for the MPL.

The method employed has been a combination of literature and interviews with MPL stakeholders, or perhaps a literature review supported by interviews. Openly available material on the MPL has been explored, mostly from electronic sources. Also, attendance on conferences has allowed access to experts presenting on the MPL, the presentations themselves as well as a network within the training industry. This network facilitated identification of professionals with expertise and experience in regards to the MPL, of who some were contacted for interviews.

While there has been many presentations at international aviation conferences as well as industry papers on the topic of the MPL, an overview and review of this new training regime has been lacking and especially one that does not represent the "training industry insider" perspective most often represented at these conferences as well as in higher level texts about the MPL. The purpose of this report is thus to put forward a report that broadly outlines the background, development and introduction of the MPL as well as engages in a critical analysis of the early experiences and current status of the MPL and its future. In addition the aim has been to produce a report that is easily accessible and readable to allow it to be disseminated beyond managerial levels in the industry and prompt increased interest, awareness and discussion on the MPL as well as on pilot training in general.

Since the purpose and aim of the report may seem ambitious for a bachelor thesis it is important to also be clear about the limitations of this report. These limitations are that the report is not, and has not been intended as a comprehensive research project that analyses or evaluates the MPL in depth. This would require further resources, time and certainly more extensive data collection than this limited literature and interview study has allowed. Also, the report make no claims to have had full and extensive access to detailed insider knowledge and experience from top levels of rule-making agencies or management in the industry, rather it is use of openly available information and direct contacts with stakeholders which are the sources for the collected data. This transparency allows the report to be critically peer-reviewed since the material used in the report can be accessed by any reader of the report. Nevertheless, the approach of putting this report together has been the same as for any thesis project in regards to the intent to collect, analyse and discuss data, i.e. to do so in order to gain understanding of a topic or a specific issue.

Overall this report has been developed in a similar way to that of a previous report commissioned by the Swedish CAA, i.e. the report “Crew Resource Management, Threat and Error Management, and Assessment of CRM Skills - Current situation and development of knowledge, methods and practices” by Nicklas Dahlstrom, Jimisola Laursen and Johan Bergstrom. This report was initiated as a bachelor thesis but expanded in scope due to stakeholder interest and ended up as a formal report on behalf of the Swedish CAA, originally in Swedish but later translated by the Swedish CAA into English for wider dissemination. Since this previous experience of using the synergy between a thesis and an observed need for an overview and review of a topic was positive this approach has been employed also for this report.

In highlighting intent and limitations it is also pertinent to declare that part of the basis of this thesis came from the MPL and Bachelor program at Lund University School of Aviation. Although the majority of the gathered experiences of the MPL has been sought out from other sources it is safe to say that the MPL-experiences has so far not been widely shared within the aviation training community. Being well aware of the limitations of this report, the purpose has remained as described here above, and hopefully this report can lead to an increasing engagement between the different industry stakeholders of pilot training issues and especially of the MPL. If this happens to be the case then the report has fulfilled its purpose.

# 5. THE HISTORICAL BACKGROUND

## 5.1 - The history of pilot training and licensing

On December 17 in 1903 a new chapter of modern history began as Orville Wright performed the first flight with a heavier-than-air powered aircraft carrying a pilot onboard (Smithsonian, 2013). The flight lasted around 12 seconds over a distance of 120 feet and it is difficult to imagine that in the first 50 years after this epic event, aircraft would be produced with wingspans that were greater than the entire distance traversed during that first flight (Rockliff, 2012). In fact, today there is even an airliner that has a horizontal stabiliser with a span that also exceeds the distance of that first flight.

It did not take very long after the Wright Brothers invention for pilot training and licensing issues to first be discussed, and shortly after developed into practice. The main reason for this was to ensure the safety of people both in the air and on the ground and this required the aircraft to be under the responsibility and operational control of a properly trained, certified and current pilot at all times. Although the technology in a modern aircraft today is barely comparable with the Wright brothers aircraft from more than a century ago it can be argued than one aspect remain unchanged. As stated by ICAO – "As long as air travel cannot do without pilots and other air and ground personnel, their competence, skill and training will remain the essential guarantee for efficient and safe operations" (ICAO, n.d.).

The history of aviation is filled with important and interesting episodes. However, since the focus of this report will be on pilot training and licensing the historical perspectives covered will focus on the ones considered relevant and interesting for a fundamental understanding of the development and changes up until present time.

Early aviation developed mainly in the United States and Europe, France in particular, and here one of the first aviation bodies was founded at a conference held in Paris in October 1905 - the Federation Aeronautique Internationale (The World Air Sports Federation, FAI) (FAI and ICAO, n.d.). The conference was organised following a resolution passed by the Olympic Congress held in June in Brussels the same year that called for a creation of an association "to regulate the sport of flying, the various aviation meetings and advance the science and sport of aeronautics" (ICAO, n.d.). Eight countries attended with representatives from their respective aviation organisations; Belgium, France, Spain, Italy, Germany, Great Britain, Switzerland and the United States. It was the Aéro-Club de France, one of the founding members to the FAI, who just a couple of years later issued the first license to Louis Blériot, on 7 January 1909 (the first person to cross the English Channel in a heavier-than-air aircraft, in that same year). The first fourteen licenses were awarded in alphabetical order to aviation pioneers considered to have amply demonstrated their abilities and therefore they were not required to pass any examination in order to receive their licenses. Another famous example of persons to who were up for receiving early licenses were the Wright Brothers. Soon after the Royal Aero Club in the UK were among the first to continue this development and began issuing licences in 1910 (Blake, n.d.).

Based on the Aero Club de France, the equivalent organisation in the United States, the Aero Club of America, similarly worked advancing aviation in different ways. This organisation was also formed around 1905 as an offshoot of the already existing American Automobile Association (Wright Brothers Aeroplane Company, n.d.). The popularity of aeroplanes increased significantly after public flights were performed by the pioneers of aviation and people who were amazed by these performances started looking for opportunities to learn to fly themselves. Initially, these opportunities involved great risk and the first solo flight would usually coincide with the first time that the student pilot was airborne. In those days many people built their own aeroplanes and they were also often the ones to test fly them. When a person decided to buy an aeroplane from one of the manufacturers that manufacturer also offered training to teach the buyer how to fly and operate it properly.

The first licences issued by the Aero Club of America were not mandatory but more for prestige and to show off to others. There was however from quite early on some individual states that required licenses (New York Times, 1913). In the early 20th century the qualifications to receive a licence were not standardised and could be consist simply of taking off and flying a course of a figure eight at a given height. Another example is from Von Porat (cited in Christofferson, 1982, p. 46) who remembers the first directions given to him: *"I was instructed to ascend and fly on a straight line along the runway, but I cannot recall any instruction on the hereafter necessary landing."*

Fortunately, with increasing knowledge and advancing technology also came higher qualification requirements. In was however not until 1926 that pilot licensing became a federal matter in the United States as a result of the Air Commence Act in that same year. The act included, among other regulatory requirements, the licensing of pilots and the first one issued, in April 1927, was for William P. McCracken Jr (seen in the image to the right). Before accepting the license McCracken offered the honour to Orville Wright, as he would be more deserving of this honour. Wright declined since he no longer flew and did not feel that he needed a license to show that he had been the first man to fly.

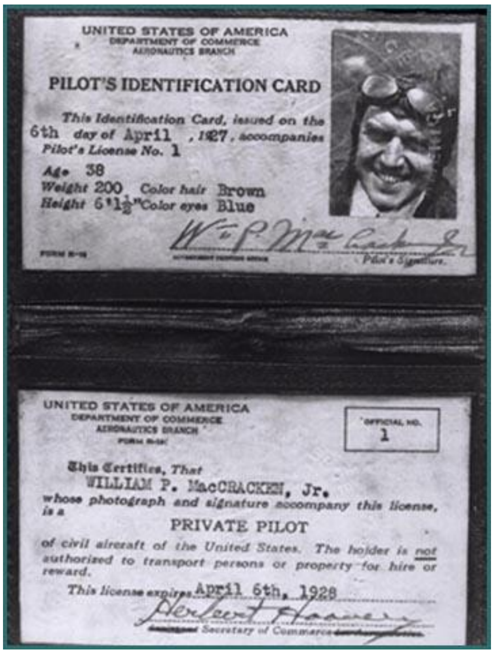


*Fig 5.1 – The first license issued in the United States. (Source: Aviation Online Magazine, 2013)*

### 5.2 - War created a legacy that would last

As history progressed the time of war soon became reality and with this a new era and a new focus on aviation development and pilot training. The three decades marked by war from World War I (1914-1918) to World War II (1939-1945) brought remarkable technological advancements of aircraft. This increased potential for use of aircraft in armed conflict also meant that there now was an increased need for skilled professionals to pilot them. WWI was the first conflict to use aircraft as fighters and bombers as well as for reconnaissance. The armed forces of many countries started to invest time and funds to provide pilots some form of training to handle the flying machines, preferable as short as possible so that they could join and support the war effort.

The biggest change and action came during the years preceding WWII when several European countries as a response to the increased tension in Europe, especially Italy and Germany, began training thousands of young people at flight academies for the future role as a commanding pilot of an aircraft. The academies were purportedly civilian in nature but were in fact nothing else than government-funded military training facilities with a purpose of supplying sufficient pilots in case a new war would erupt. In October 1938 the United States followed the European example and established the Civilian Pilot Training Program (CPTP), however its potential for national defence was undisguised. The program started in 1939 with the government paying for a 72-hour ground school course and 35 to 50 hours of flight instruction on locations near eleven colleges and universities. It was an unqualified success and became a grand vision to its supporters – to greatly expand the number of civilian pilots by training thousands of college students to fly. The armed forces was at first unimpressed by a program initiated and run by civilians, but when Germany invaded Poland in September 1939 and triggered WWII, the military value became obvious since at the time military pilots, instructors and aircraft were all in short supply. Soon after the CPTP changed its name and became known as the War Training Service (WTS) when under military control.

The history of war is a story in its own, but what is of interest here is in what way this provided a new foundation in how to train and prepare pilots. The priorities related to an approaching or ongoing war proved to be that of training for the shortest possible amount of time and with focus only on aircraft handling skills, also referred to as “stick-and-rudder-skills”. The historical background and military roots have in different ways remained influential for the way pilots are trained and it created a foundation for civil pilot training for decades to come. In regards to the MPL, the military legacy would prove to be of relevance once again and is further discussed together with other topics in this report. Only a few years after the war had ended, the International Civil Aviation Organisation (ICAO) was founded. As ICAO still is an active and influential sovereign body of civil aviation, also closely involved in the development of the MPL, it becomes of interest to review the history and development of this organisation. The information that follows has been sourced from ICAO.

## 5.3 - The history of ICAO and development of practices

Already in the early years of aviation people with foresight had realised that the potential of air transport added a new dimension to transportation that would no longer be contained within national boundaries. It was for this reason that, on the invitation from France, the first important conference on an international air law code was convened in Paris in 1910. This conference was attended by eighteen European states and a number of basic principles governing aviation were laid down.

However, the technical developments in aviation arising out of World War I created a completely new situation at the end of the war, especially with regard to the safe and rapid transport of goods and persons over prolonged distances. The war had also shown the destructive potential of aviation and it had therefore become much more evident that this new and now greatly advanced means of transport, required international attention. The handling of aviation matters was therefore a subject at the Paris peace conference in 1919 and it was entrusted to a special Aeronautical Commission. At the same time, civil air transport enterprises were created in many European countries and in North America, some of which were already engaged in international operations. Also in 1919, two British airmen named Alcock and Brown, made the first west-east crossing of the North Atlantic from Newfoundland to Ireland and the "R-34", a British dirigible, made a round trip flight from Scotland to New York and back.

It was events like these which incited a number of young aviators to propose that the international collaboration in aviation matters, which had been born out of military necessity during and immediately after World War I, should not end with the end of the war. This work should now be refocused for peaceful purposes and the development of post-war civil aviation because it was believed that aviation had to be international - or not at all. This proposal was formally taken up by France and submitted to the other principal allied powers who received it favourably. Their collaborate action then resulted in the drawing up of the International Air Convention, which was signed by 26 of the 32 allied and associated powers represented at the Paris peace conference and was ultimately recognised by 38 states. This convention consisted of 43 articles that dealt with all technical, operational, training related and organisational aspects of civil aviation and also foresaw the creation of an International Commission for Air Navigation (ICAN) to monitor developments in civil aviation and to propose measures to states to keep abreast of developments. It should be noted that this convention took over all the principles that had already been formulated by the conference that had been held in 1910 in Paris.

By the spring of 1942, more than two years before the end of World War II, it was apparent that civil air transport also would play a large and important role in international relations and serious discussions of political and diplomatic arrangements for international civil aviation had begun mainly in Canada, the United Kingdom and the United States. At the Anglo-American Conference held in Quebec City from 10$^{th}$ to 24$^{th}$ August 1943, Roosevelt and Churchill discussed post-war aviation policy and were planning for a United Nations type of organisation to handle some aspects of international civil aviation.

Following this it became in 1944 even more apparent that the time was rapidly approaching when some nations would want to initiate new international air services on a regular commercial basis. On 11 September 1944, the United States extended an invitation to fifty-three governments to an international civil aviation conference, to be convened in the United States on 1 November 1944. The invitation read: to "make arrangements for the immediate establishment of provisional world air routes and services" and "to set up an interim council to collect, record and study data concerning international aviation and to make recommendations for its improvement." The conference was also invited to "discuss the principles and methods to be followed in the adoption of a new aviation convention." Opened as planned on 1 November 1944, the Chicago Conference, as it came to be known, lasted for 37 days instead of 25 as originally anticipated. On 7 December 1944 the conference was concluded with the signature of a final act that was a formal and official record summarizing the work. Signing of the agreement was documented and an image of this can be seen below.

*Fig 5.3 – Agreements signed at the end of the Chicago Conference on 7 December 1944 in the Grand Ballroom of the Stevens Hotel, Chicago. (Source: ICAO, 2013)*

The result was the Provisional International Civil Aviation Organisation (PICAO) which was established as an interim body pending the ratification of a permanent world civil aviation convention. The Canadian government chose Montréal for locating PICAO's headquarters, as it was at that time the leading metropolis of the country, the most cosmopolitan and international city and also the main hub for international civil air transport. The Convention on International Civil Aviation was opened for signature and designed to provide a complete modernization of the basic public international law of the air. After ratification by twenty-six states, it came into effect on 4 April 1947 with the constitution of the new permanent International Civil Aviation Organisation, ICAO, thus bringing an end to PICAO.

The body of ICAO consists of an Assembly, a Council and a Secretariat. The Assembly is the sovereign body of ICAO and is composed of representatives of all of the contracting states. The Assembly meets on a three-year interval to elect the Council, which acts as the governing body of ICAO for a three-year term after this election. The Council is composed of members from 36 states and formulates the various types of standards and other provisions. Standards and provision exists in four main types:

*1. – Standards and Recommended Practices (SARPs)*
*2. – Procedures for Air Navigation Services (PANS)*
*3. – Regional Supplementary Procedures (SUPPs)*
*4. – Guidance Material*

Of those four the SARPs are the most important type of provision, and they are included in the, originally 12, but today 19 Annexes to the Chicago Convention. They are applied universally and produce a high degree of technical uniformity which has enabled international civil aviation to develop in a safe, orderly and efficient manner. To facilitate the development of these SARPs, the Council is assisted by the Air Navigation Commission (ANC) in technical matters, the Air Transport Committee in economic matters and the Committee on Unlawful Interference in aviation security matters. Any contracting state, international organisation with interest in the civil aviation community or ICAO itself, may submit a proposal for a new SARP or call for the need to revise an existing one. Proposals concerning a technical SARP are first analysed by the ANC. The ANC in turn is composed of fifteen experts with appropriate qualifications and experience in various fields of aviation. The members are nominated by the contracting states and appointed by the Council. Depending on how complex the proposal is considered to be, a specialised working group may be assigned by the ANC to facilitate the review process. One type of such a specialised working group is an ANC panel which are composed of qualified experts to advance, within specified time frames, the solution of specialised problems which cannot be solved adequately or expeditiously by the established facilities of the ANC. Once the review process is complete, a report is submitted to the ANC in the form of a technical proposal, either for revision(s) to existing SARPs or for the creation of new ones. In turn, the ANC then reviews the proposal and submits it to the Council for action. The Council performs an additional review and decides whether the proposal should be adopted as an amendment to the Annexes, or some other type of provision such as the ones already mentioned. The requirement for an amendment to the Annexes is a two third majority of the Council. Once the amendment(s) have been adopted by the Council, the contracting states are given three months to indicate disapproval of the amendment. Unless a majority of them indicates disapproval, the amendment will become effective and the contracting states assume the responsibility of implementing the change(s) accordingly. This also calls for a clarification of the difference between standard and recommended practice. The ICAO definitions read:

A ***Standard*** is defined as *"any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognised as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention."*

A ***Recommended Practice*** is defined as *"any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognised as desirable in the interest of safety, regularity or efficiency of international air navigation and to which Contracting States will endeavour to conform in accordance with the Convention"*

If a State chooses not to implement the amendment(s), the state will in turn be required to submit a written "notification of differences" on Standards but is invited to submit such a notification on all Recommended Practices. In other words, every contracting state are required to adapt to a new or amended Standard while a Recommended Practice not is mandatory and the contracting states are merely encouraged to implement its content.

The part covering pilot training is Annex 1 – Personnel Licensing. One of ICAO's main tasks in the field of flight crew licensing is to move towards a minimum of differences in licensing requirements and to ensure that international licensing standards are kept in line with current practices and probable future developments. This is even more important these days as flight crew will be exposed to increasing traffic density and airspace congestion, highly complicated terminal area patterns and ever more sophisticated equipment. To accomplish this task, Annex 1 and the related manuals are regularly amended to reflect the rapidly changing environment. The MPL has also been developed during a process like the one described above and is covered next.

# 6. THE MPL ORIGIN AND DEVELOPMENT

## 6.1 -The MPL initiative and birth

The ambition to develop internationally standardised pilot training was initiated by establishment of the ICAO and the adoption of Annex 1 in 1948, based on the outcomes from the Chicago convention in 1944 (ICAO, 2013). Since then the traditional training for airline pilots has followed a prescriptive task-oriented and hours-based syllabus with very limited change (IATA, 2011).

The legacy process, as described by IATA (2009), has its origin from a time when the way to airline employment was long and hard. Pilots gathered flying hours and experience mainly within general aviation, e.g. by flying parachuters, doing taxi flights or working as flight instructors. With enough experience the pilot were then later able to transition to an airline jet aircraft and begin flying for an airline, normally after some initial base training.

The need to update and review current pilot training was actually formally first recognised as early as in 1982 and the first ICAO attempt to adapt to the changes in the airline industry was the installation of the Personnel Licensing and Training Panel (PELTP) from 1982-1986 (IATA, 2011). The panel unfortunately failed when their final proposal could not garner the necessary support from the Air Navigation Commission (ANC) and the ICAO Council, thus resulting in no change to pilot training. The discussions did however continue.

According to Scheck (2006) a new request to review existing pilot training and licensing requirements originated from Germany sometime around the beginning of the new millennium. German flight academies, in particular the Lufthansa Flight Academy, have had a long history of ab-initio flight training programs and some of the German airline flight training managers felt that the existing flight training standards were outdated. This is confirmed by Dieter Harms (2013), previous head of training at Lufthansa Flight Training (LFT).

IATA (2009) stated that when comparing the content of the training needed to obtain a traditional Commercial Pilot License (CPL) with common modern airline operational procedures the results revealed an increasing gap that needed to be attended to. In fact, training itself was claimed to have become an obstacle to the application of industry best practices, simply by not keeping the same developing pace as the rest of the aviation industry. Traditional ab-initio training developed skills which in large part were said to be irrelevant to the operation of modern multi-crew transport aircraft. Light piston-driven aircraft had little in common with airliners in commercial service, perhaps even promoting negative training and potential future risk. Over the three most recent decades airline pilots had been trained in single pilot airplanes with substantially limited crew coordination training capability, even though crew coordination and crew resource management were important training objectives.

IATA (2009) also stated that the need for a change was based on future threats that had become more visible. Human Factors remained the most significant cause of accidents and incidents. The airline industry also faces multiple challenges during growth, most significantly the prospect of more accidents if the accident rate cannot be reduced. Additional training would become a major cost challenge for the industry and the search for more relevant training was needed. The industry now also had access to new flight simulator technology of revolutionary capacity, but which was far from being used to its full potential.

As these forces converged ICAO recognised the need to review training standards, which led to a second attempt to approach this issue in October 2000 in Madrid. The confirmation resulted in the installation of the ICAO Flight Crew Licensing and Training Panel (FCLTP). In fact, this would be the first major review of existing practices in 25 years and one with an ambition to create an alternative approach to pilot training and licensing (Scheck, 2006). The FCLTP had 64 participants, including members and observers nominated by eighteen Contracting States and five international organisations. Those participating agreed that the evolution in technology, such as increasingly automated airline operations, called for a review and adjustment of current flight crew licensing and training standards. The early analysis was that the increase in automation had resulted in a shift of the required skills, from the previous focus mainly on manual flight skills to more cognitive skills and that pilot training should reflect this development (Scheck, 2006). In addition, there was also general consensus among the members of the FCLTP that the current flight crew licensing and training standards could be improved by incorporating the advancements made in modern training methodology and technology. Much had happen since the 1940s. Some of the advancements involved competency-based training (CBT) and instructional systems design (ISD), together with the ever more advanced flight simulation training devices (FSTDs) and modern information technology such as computers and the Internet. As ISD, CBT and FSTDs are all fundamental aspects to the MPL training and programme design they are all later reviewed.

The FCLTP worked on proposals and/or amendments on identified changes between 2002 and 2005. According to Forbes (in Scheck, 2006, p.21-22) this resulted in the following:

- *Amendments to Standards and Recommended Practices (SARPs):*
  *Annex I Flight Crew License Requirements*
  *Annex 6 Part I & Part III Training Requirements Recommendations for certification/approval of Training Organisations*
- *Approval of Training Organisations with regards to this new training methodology*
- *Development of proposals for a Multi-Crew Pilot License (MPL) – Aeroplane*

*The foundational elements of the MPL can be summarised as:*
- *MPL is additional license and not a substitute to existing requirements*
- *Focused on ab-initio airline pilot training*
- *Competency based training & assessment*
- *Greater emphasis on FSTDs*
- *Training based in multi-crew environment*
- *Emphasis on Crew Resource Management (CRM)*
- *Threat and Error Management (TEM)*
- *Medical Standards same as existing licenses*
- *Core flying skills including mandatory upset training*

The ANC then went through the process described in the previous section and the product of their work ended in an ICAO adoption of the results and the new Annex 1 – Personnel Licensing. As a part of the Procedures for Air Navigation Services, Training (PANS-TRG) Doc 9868 would contain the MPL and it was released in November 2006. The transposition into the Joint Aviation Requirements (JARs) went in parallel, and in December 2006 the new JAR-FCL Amendment 7 including MPL was distributed. Transposition into the European Aviation Safety Agency (EASA) Part FCL followed and was completed during 2012.

ICAO and IATA (2011) stated that the MPL was not meant to replace existing forms of training but to offer an alternative training method. However, exactly how the MPL was to be benchmarked to the already existing flight training programs became heavily debated within the FCLTP and still is in the industry in general (Scheck, 2006, ECA and IFALPA 2005-2013). One of the biggest area of controversy has been the question of how many hours of flight training, in particular in an actual aircraft (vs. a synthetic training device), that should be considered the base-line for MPL training. This issue is also more discussed with later topics.

IATA (2009) describes the Multi-Crew Pilot License as tailored to guide students seamlessly from ab-initio training to an airliner type rating, using simulation designed for multi-crew training. The idea behind the concept is to focus on the actual skills required in a modern airline cockpit rather than a pre-determined amount of flying hours – a main component in competency-based training. In essence, the MPL provides an alternative path for certain approved training organisations (ATOs) with previous experience in ab-initio training to explore ways to streamline, improve and adapt existing ab-initio training for airline co-pilots by incorporating modern training tools and methodologies like the ones described. From this perspective, the MPL also becomes comparable to other attempted alternative training program such as the FAA's Advanced Qualification Program (AQP). The AQP allow airlines to make pertinent deviations from the requirements of traditional training programs provided that they can demonstrate to the FAA's satisfaction that the resulting proficiency and quality will meet or exceed those gained via the traditional path (FAA, 2013). In the case of the MPL that would be the proficiency and quality of an airline co-pilot. This leads to the issue of how MPL training and the programme design for it actually looks.

### 6.2 - The MPL training and its design

ICAO (2013) states that the course development methodology of the MPL should be based on the already mentioned Instructional Systems Design (ISD) and thus this approach requires a brief explanation before the MPL training can be described. Instructional Systems Design has also been presented as Instructional Systems Development or Systems Approach to Training (SAT) in different contexts, but the meaning remains the same.

ISD is a modern and systematic engineering approach towards development of training and performance standards (Teunissen, 2002). The concept emerged in the 1960s, but the incorporation with training development accelerated first in the 1980s and initially mainly with the US armed forces (Scheck, 2006). The ISD concept is generic and comes in many forms. For this reason there have also been many different approaches to its appliance. Teunissen (2002) state that ISD has become a discipline of its own in aviation training that encompasses an iterative process from analysis to implementation of training and performance evaluation. The scope of this paper does not intend to compare different approaches but limits the review to an explanation of the basic concept sufficient to understand its purpose. It is also later further discussed in the context of competency-based training.

ISD breaks down training development into five interrelated phases – (1)-Analysis, (2)-Design, (3)-Development, (4)-Implementation and (5)-Evaluation. A visualization of this can be made from the model below.

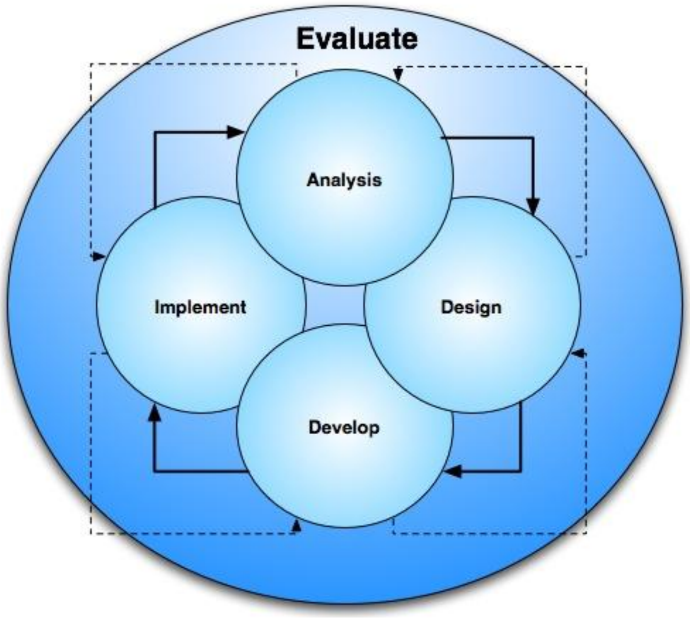


*Fig 6.2 (1) – The phases of the Instructional Systems Development (ISD) model. (Source: Clark, D.R., 2013)*

Clark (2013) argues that while some learning theory is part of the descriptive sciences, which describe the way things function in the natural world, Instructional System Design is more a part of the design sciences, which offer alternative ways to perform certain human-defined tasks.

The ISD process begins with a rigorous analysis of the profession for which the cadet is to be trained. This analysis should include a study of the organisational system in which personnel must work, the critical aspects of individual functions of the profession and the performance levels required for each function in that profession. This analysis is referred to as "task analysis" (Teunissen, 2002). Then, based on outcomes of this task analysis, performance standards are set and a training curriculum can be designed. The next step would then be to develop and implement a training programme in accordance with the designed curriculum. This creates an apparent benefit and advantage to training as there is a direct link between training standards and the specific requirements of the profession. Specifically for MPL training there is a requirement for a feedback and quality assurance system that is harmonised within the training organisation (such a system is later described and discussed). An additional benefit of this approach is that the process itself and the resulting documentation remain known to any user involved (Teunissen, 2002). If successful, the process enables and ensures that training programmes and performance standards can keep pace with changes in professional requirements as well as with the cadets' achievements of the targeted training outcomes. Given the dynamically developing nature of aviation, this logically becomes essential to optimise training conditions.

One crucial aspect of ISD is that the five phases are interrelated and that changes in any of the phases will have an impact on the entire system. Again, ISD is a truly iterative approach. This means that the various phases connects to each other and that the process never is complete, but rather a constant repetitive loop to ensure continuous optimisation of the training program and content. From the model this can be seen in that "evaluation" surrounds it all and needs to be incorporated into each of the other phases. In addition, as stated by Clark (2013), an important aspect is not to get caught up in an old development philosophy or adage that says *"if it isn't broke, don't fix it"* – it can always be improved and the ISD methodology should allow for continuous improvements to be made. What has been described here relates to how Blaiwes et al, (in Scheck, 2006) summarised optimisation of training programs. They view aviation training optimisation as a continuous process, involving complex experimentation to determine the best mixture- and sequence of academic training, on-the-job training and simulator time.

ICAO (2013) has acknowledged that there are different ISD models that could be equally appropriate to apply in the development of a competency-based training – or that perhaps no single methodology contains all the required elements. Logically, this will potentially require the use of a number of methodologies in the design of a particular course. However, methodological prescriptions are considered counterproductive as training methodologies should reflect the flexibility and adaptability in order to accommodate any changes in new circumstances, goals and technology. With this in mind ICAO has not published any material on differences in available systems approach to methodologies and models and instead only states that what is important in the methodology used is that it contain the ISD elements that govern the three basic procedural steps of a needs analysis, design and production, and evaluation (PANS TRG, 2013). This is one of the reasons to why there are several different designs of MPL training programmes currently up and running. In the following section the basic ICAO MPL training scheme is described.

An MPL training course is generally divided into four phases, often referred to as Core, Basic, Intermediate and Advanced. IATA (2011) states in their MPL guidance material that this four-phase breakdown is intended as a preliminary conceptual model to facilitate the transfer from hours-based to competency-based training and that fully developed CBT schemes does not need any division. Instead, it only requires a well-functioning student management system to assure that the progress of each student follows predetermined norms in all competencies together with clear definitions of the terminal training objectives. The minimum requirements in terms of flight hours for the completion of an MPL training course is 240 hours of which 30 has to be performed in an actual aircraft. Those 30 hours, however, requires clarification as different material argues for a different amount of hours. ICAO Annex 1 containing the licensing requirements for the MPL states under the section of experience:

> 2.5.3.2 Flight experience in actual flight shall include at least the experience requirements at 2.3.3.1, upset recovery training, night flying and flight by reference solely to instruments.

In turn, 2.3.3.1 contains the experience requirements for the PPL and states:

> 2.3.3.1 *Experience*
>
> 2.3.3.1.1 The applicant shall have completed not less than 40 hours of flight time, or 35 hours if completed during a course of approved training, as a pilot of aeroplanes appropriate to the class rating sought. The Licensing Authority shall determine whether experience as a pilot under instruction in a flight simulation training device is acceptable as part of the total flight time of 40 hours or 35 hours, as the case may be. Credit for such experience shall be limited to a maximum of 5 hours.

As PPL training will be performed as a part of a course of approved training, the number of hours required becomes 35 of which five could be done in a flight simulation training device, resulting in the suggested minimum of 30. It should be noted that this is the ICAO minimum and that obtaining the PPL itself is not a required part of MPL training although the hours required are based on that regulation. Most of the European MPL training providers have still decided to incorporate a PPL into their training curriculum (Eriksen, 2010). For EASA states the minimum amount of hours have also been raised, as the EASA regulations requires 45 hours of which five could be done in a simulator, thus making the minimum 40 actual flight hours (EASA Part FCL, 2008). There are also other examples where aviation authorities have required MPL cadets to obtain a PPL, such as with the Civil Aviation Department Hong Kong (HKCAD) (IATA, 2011), which happened at least during a beta trial of the MPL. An overview of the basic ICAO MPL training scheme and the general contents of the different phases can be viewed on the next page. A short summary is also listed below.

***PHASE 1, CORE*** *– Phase one consists mainly of single-pilot training in aircrafts and FSTDs to consolidate basic aeronautical knowledge in the real environment including upset recovery, basic instrument flying and night flying.*

***PHASE 2, BASIC*** *– In phase two the MPL cadets will be introduced to multi-crew operations and instrument flight, operating as both pilot flying (PF) and pilot not flying (PNF).*

***PHASE 3, INTERMEDIATE** – Phase three brings the application of multi-crew operations in a high performance multi-engine turbine aircraft.*

***PHASE 4, ADVANCED** – In phase four the type rating training is performed within an airline oriented environment that ends with a number of touch-and-go landings, also referred to as base training. The final sessions in the simulator together with the base training is at the same time a skill test for type rating, the MPL license and the instrument rating (IR). If successful, the IR is integrated into the MPL license.*

Not listed in the MPL training scheme is that with a successful outcome of the skill test, the MPL cadet then needs to perform the initial operating experience (IOE) with a connected host airline. This part is often referred to as line flying under supervision (LIFUS) or Line Training (LT), where the cadet flies at least a regulatory minimum, or a minimum number of flights in accordance with the operations manual (OM) of the airline. This part ends with a line check and if successful also here, the MPL cadet has now completed his or her training. The theoretical requirements remain the same as for the ATPL for now. IATA (2011) states that the theoretical examinations generally are administered before commencing the practical training in Phase two. A list of the fourteen subjects can be found below.

– *Air law*
– *Aircraft general knowledge*
– *Communications (VFR & IFR)*
– *Flight planning and monitoring*
– *General navigation*
– *Human performance and limitation*
– *Instrumentation*
– *Mass and balance*
– *Meteorology*
– *Operational procedures*
– *Principles of flight*
– *Performance*
– *Radio Navigation*

## MPL Training Scheme

**Minimum 240 hours of training, including "Pilot Flying" (PF) and "Pilot Non Flying" (PNF)**

Integrated TEM Principles

| Phase of training | Training items | Flight and simulated flight training media with minimum level of requirement | | Ground training media |
|---|---|---|---|---|
| **Phase 4 Advanced**<br><br>Type rating training within an airline orientated environment | • CRM<br>• Landing training<br>• All weather<br>• LOFT<br>• Abnormal procedures<br>• Normal procedures | Aeroplane: Turbine Multi-engine<br><br>Multi-crew certified<br><br>FSTD:<br><br>FS Level D or C+<br><br>ATC simulation | 12 take-offs and landings as PF<br><br>-----------<br><br>PF / PNF | CBT<br><br>E-learning<br><br>Part task Trainer<br><br>Classroom |
| **Phase 3 Intermediate**<br><br>Application of multi-crew operations in a high performance multi-engine turbine aeroplane | • CRM<br>• LOFT<br>• Abnormal procedures<br>• Normal procedures<br>• Multi-crew<br>• Instrument flight | FSTD: Representing a multi-engine turbine powered aeroplane to be operated with a co-pilot and qualified to an equivalent standard to Level B+<br>ATC simulation | PF / PNF | |
| **Phase 2 Basic**<br><br>Introduction of multi-crew operations and instrument flight | • CRM<br>• PF / PNF complement<br>• IFR Cross-country<br>• Instrument flight | Aeroplane:<br><br>Single or multi-engine<br><br>FSTD:<br><br>FNPT II + MCC | PF / PNF | |
| **Phase 1**<br><br>**Core Flying Skills**<br><br>Specific basic single pilot training | • CRM<br>• VFR Cross-country<br>• Solo flight<br>• Basic instrument flight<br>• Principles of flight<br>• Cockpit procedures<br>• Upset recovery<br>• Night flight | Aeroplane:<br><br>Single or multi-engine<br><br>FSTD:<br><br>FNPT I / BITD | PF | |

*Fig 6.2 (2) - The ICAO MPL training scheme (Source: IATA, 2011)*

### 6.3 – The MPL implementation and early development

Although the aviation industry agreed that training and licensing standards needed to be amended and was one of the driving forces behind the ICAO MPL initiative (ALPA, 2008, p.1), it was not convinced that the efforts made by aviation authorities when introducing the MPL would fully address the challenge. From what have been mentioned, it would make the MPL a natural response to changes in aviation that theoretically should have been embraced by the industry. As expressed by Mikhailov (2011, p.2) *"it might therefore come as a surprise that upon release of the MPL, the organisations meant to represent the interest of pilots have received it with what can be seen as a high degree of apprehension."* Debate, critical statements and other opinions about the MPL started to appear even before the license had been implemented. The European Cockpit Association (ECA), representing over 38 000 pilots from national pilot associations in 37 European states (ECA, 2013), along with the International Federation on Air Line Pilots' Associations (IFALPA), representing over 100 000 pilots internationally (IFALPA, 2013), made the following statement in 2005; *"The reduction in actual flying hours in the Integrated Multi-Crew Pilot License training course by 50% is UNACCEPTABLE"*. (ECA and IFALPA, 2005, p.2) The conclusion in the very same statement read "*The general opinion of the pilot organisations is that the current proposal represents a very real threat to safety because it downgrades the training quality standards and is driven mainly by an economic interest. It should therefore be rejected in its present form and adapted to the above mentioned criteria under the involvement of the pilot organisations"*. (ECA and IFALPA, 2005 p.2)

As stated by Learmount (2008) the MPL initially seemed to mean something different to each person who expressed an opinion about it. *"Many views are dismissive, suspicious or patronizing. Opinions range from the belief that it is designed as a quick, cheap cure for the world pilot shortage to the idea that it is destined to create career first officers"*. Learmount (2008) continues his article with *"Most opinions like this are voiced by those unfamiliar with the objectives to which the International Civil Aviation Organisation anchored the MPL"*, suggesting that the resistive opinions would be based on misunderstandings or lack of knowledge regarding the concept and its related background.

The Air Line Pilot Association, International (ALPA), representing around 50 000 pilots and being the world's largest airline pilot union stated in a white paper published 2008 on the MPL that *"The new Multi-Crew Pilot License (MPL), if applied correctly and subjected to careful monitoring of the competency of the newly trained pilots, could produce a highly qualified new hire first officer for the airlines. However, if applied incorrectly in response to cost or time pressures designed to simply address the current pilot shortage, it could have a detrimental impact on flight safety. Improper application may also erode current, time-proven training standards"*. (ALPA, 2008, p.7) As mentioned, there were widespread early beliefs regarding the MPL origins that it was designed to address rapid growth and accelerating pilot delivery to airline companies by reducing training time. (IATA, 2013, p.3) This was later discredited with counterstatements based on that there were no projected rapid growth when discussions regarding a new license were re-initiated in 2000. (Bent, 2011, p.20)

As 2010 was coming to an end, MPL proponents were disappointed about the apparent slow adoption worldwide. At this time only 30 states had adopted MPL regulations and in just 12 of them MPL courses were being conducted. Even worse, only 7% of the, at the time 190, ICAO contracting states had approved training organisations to conduct MPL programmes. (IATA, 2013) The resistance faced was analysed and divided into two different approaches or perspectives – financial and general. When Doc 9868 covering the MPL was published in 2006 it was just prior to one of the deepest recessions in 50 years, limiting the training providers' resources required to re-organise and launch MPL training (IATA, 2011). The pure fact that the training also required more dedicated training devices (FSTDs) and that the instructor requirements became more stringent meant additional costs. In addition to this and as argued by Dahlstrom (2007) it is possible to question if the safety and effectiveness of basic civil aviation training is or ever has been a top priority for the aviation industry. Throughout the history of aviation scores of young people aspiring for a career as a pilot have been available to the industry. This has enabled the industry to focus its efforts on improvements in other areas than that of basic civil aviation training. The theory of basic training being a low priority for the industry can also in way be confirmed in this matter by IATA who felt resistance amongst key operator decision makers who said; *"As we meet regulatory requirements, why should we add more training?"* (IATA, 2011)

Besides misperceptions about the origins of the MPL the reasons behind a slow acceptance process in some extent consisted of regulatory inertia. In Europe the flight crew licensing requirements (FCL) at this time, before the European Aviation Safety Agency (EASA) took over responsibility from the Joint Aviation Authorities (JAA), were devised by the JAA. This meant that there was a mutually agreed European standard but not a pan-European legal requirement and in order to become legal Joint Aviation Requirements flight crew licensing (JAR-FCL) had to be written into each European Union country's aviation law. This resulted in that each national aviation authority had to validate and approve any MPL program that took place in its home state. Theoretically it meant re-inventing the MPL-wheel requiring a lot of time and effort and most European airlines were reluctant to support this until an EASA-approved regulation was in place that defined performance standards and criteria (Learmount, 2008). IATA described it by saying *"One objective for national authorities is to guard and protect existing regulations. It is inevitable that for local authorities, regulatory change may be uncomfortable, and some reluctance may be seen despite safety dividends sought by ICAO"* (IATA, 2011). The fact that MPL was presented as a dedicated airline license and did not permit pilots to fly in other forms of aviation without additional training, thereby reducing career options on graduation, gave it the appearance of a choice with limits causing a possible reluctance from candidates (IATA, 2011). It was also explained with reference to a conservative natural change resistance as seen in the industry before. However, the general resistance contained the industry's biggest concern regarding the license; the MPL students' lower exposure to hours of flight in a real aircraft. The development in fidelity and validity of simulated training devices when used in pilot training is discussed more thoroughly in another section of this report.

In 2006 ECA complemented their statement that was jointly submitted with IFALPA in 2005: *"We continue to be surprised by the urgency expressed for the transposition of ICAO MPL proposals. This rush has led to a situation where the new scheme will neither be based upon scientific impact assessment nor on a proper risk analysis."* The statement later reads; *"In particular, ECA is concerned that the MPL could become a serious threat to safety, if not properly implemented. It risks downgrading current, established training standards and establishes a completely different and non-conventional training philosophy that envisions a considerable reduction in flying hours"* (ECA, 2006, p.2). Against this background ECA were willing to continue contributing to appropriate solutions but reserved their final position to the implementation of the MPL in Europe and stated that *"European pilots will not give their blessing to a scheme a long as they are not convinced that it will result at the very least, in an equivalent level of safety and professionalism as under the traditional ATPL"* (ECA, 2006, p.1). Based on that ICAO recommendations initially did not specify the breakdown between actual and simulated flying hours within the MPL framework, ALPA feared that the less regulated training content could be misused and stated; *"ALPA believes that the MPL standard contained in ICAO Annex I may be subject to varying interpretation by individual countries wishing to incorporate MPL into their licensing structure. Some MPL training programs may have already compromised safety by ignoring the guidance in Appendix 3 of Chapter 3 of the ICAO PANS-Training manual and have opted to maximise the use of flight simulation training devices, while minimizing training in actual aircraft in order to save costs without conducting any scientific study"* (ALPA, 2008, p.2). Another statement suggesting an alternate approach came from the chairman of the human performance committee at IFALPA, Uwe Harter, who provided (in Scheck, 2006, p.23) the following excerpts from the FCLTPs guidelines for the implementation of the MPL:

*"…MPL provides the aviation community with an opportunity to train pilots directly to co-pilot duties using to a greater extent the modern training devices such as flight simulators…general approach that is therefore suggested is to use the existing training programme (ab-initio or equivalent) of the ATO as a reference and to implement progressively the new training programme allowed by the MPL and in particular the transfer from actual flight to simulated flight…successive evolutions of the training programme introduce progressively a higher level of simulated flight and a reduction of actual flight…*"

In the latest version of the IATA guidance material and best practices for MPL implementation, released in 2011, the MPL proponents recognise this discussion initially by saying; *"MPL deliberately reduces exposure to non-relevant single pilot propeller aircraft, except for vital training objectives, and this has been seen by traditionalists as a serious limitation of MPL, until the whole program is properly understood"* (IATA, 2011, p.19). Regarding the value of training future multi-crew airplane pilots in small single pilot and propeller driven aircraft the reference is made to a working paper from the ICAO Flight Crew Licensing and Training Panel (FCLTP) presented by Otto Krueger to the panel in 2003. The content of the paper in part led to the decision to substantially reduce actual flying hours in small airplanes and replace it with structured training in real multi-crew environments (IATA, 2011). The statement ended with a note that stated "*Feedback results from operators which* *have employed the first graduates from MPL courses confirm the correctness of the statements made in this working paper"* (IATA, 2011, p.110). The paper highlights can be found in APPENDIX 1.

As an additional argument IATA also refers to an analysis made by an airline in Asia conducting an MPL program. The analysis compared line training performance during the initial operating experience (IOE) between those without previous flight experience against those with light aircraft flight experience. No correlation is said to have been found between more hours and improved performance (IATA, 2011). The result of this study is presented in APPENDIX 2.

However, there were operators with an early belief of the potential benefits of MPL. The first operator to launch an MPL program was Sterling Airlines in 2006. They worked on this with the Danish Aviation Authority and Center Air Pilot Academy (CAPA) in Roskilde, Denmark. Just as aviation pioneers needed courage to take the first step, someone needed that same courage with the MPL, following a "no guts, no glory" – philosophy. After the first MPL graduation Learmount (2008) wrote; *"The multi-crew pilot license (MPL) looks set to become the future default airline training system, despite some resistance to this new airline pilot training methodology. Initial line assessments of the first few pilots produced by the new system are favourable, and if that continues it seem likely that opposition - already declining - will crumble."* The statement was based on Sterling Airlines positive experience of the MPL cadets and Sterling's chief training pilot, Per Lilja, said; *"Their progress during line training has been good - considerably better than we have seen with other low-experience pilots."* (Learmount, 2008)

At the same time the complexity of devising an MPL program and a new training syllabus to go with it, especially without any previous experience, became apparent at the Boeing-owned airline pilot training company Alteon. With a base in Australia and an aim to train Chinese student pilots for China-based Xiamen Airlines and China Eastern, Alteon needed to work with two national aviation authorities instead of one. In addition the students did not train in their home environment and were significantly less familiar with the English language, compared to Sterling's Danish students. Alteon admitted that these prerequisites, combined with intense flying, could potentially overload the students (Learmount, 2008). One of ICAO's MPL objectives was to create and represent a minimum international pilot performance standard regardless of what part of the world the flight crews are trained and the Alteon experience made it evident that the MPL program need to vary in length based on the students' initial preparedness. "*Among the measures of that preparedness, English language skills, general education and how much exposure the students have had to technology and operating machinery all feature highly. Alteons' vice-president marketing Marsha Bell says*: *"From a training hours perspective, we're about 20% heavier than we'd originally planned in our beta curriculum"* (Learmount, 2008).

In August 2008 Sterling Airlines laid off 61 employees, including the world's first nine MPL first officers, as a result of necessary cutbacks based on a combination of high fuel prices and a prevailing economic downturn. The airline confirmed that the dismissal did not relate to the pilots' skills and referred to an often used company principle – last-in, first-out (Learmount, 2008). In the period that followed, although Sterling did their best to find other placements for its redundant pilots, the ones with an MPL license had a particular problem. In a personal interview made with CAPAs head of training, Bodil Botoft Frost, the challenges that the pilots' faced were described. *"Despite having more than 1000 hours on the Boeing 737 and enough airline experience to qualify for an employment at another airline the MPL license made it difficult to acquire one. All they needed was normal practice with an operator conversion course but based on little or no experience about the MPL, the airlines felt insecurity and suggested that the pilots should convert their license to a traditional CPL instead and then apply again."* The Danish aviation authorities even made a written statement confirming the qualification of the MPL pilots for them to use when seeking new employments, but this did not help and later resulted in a decision at CAPA to convert back to the traditional training with a CPL license -*"until the world is ready and sees the benefits"*, Frost said. However, Frost also stated that they have gained valuable knowledge from the process of designing and delivering the MPL program and have applied some of the lessons learned to its commercial pilot's course as well, with an extended MCC-course as an example. CAPA also maintains an overall positive held view of the MPL concept despite their felt hardships and Frost confirmed that they are looking for new airlines to develop an MPL program with. Since these early MPL courses the number of MPL training providers have increased and the authors have tried to gather an overview of the current implementation status.

### 6.4 – Global implementation status of the MPL

When mapping the current (November, 2013) worldwide MPL implementation status, valuable data has been provided by IATA, Dieter Harms and individual training providers. An IATA ITQI project manager, Victoria Romero (2013), also stated that one way of doing this has been by using "course trackers", a gathering document showing relevant data from all the active MPL training providers. An extract of these can be seen in APPENDIX 3 (1-3) and they provide a good overview of where, how and by whom the MPL is being delivered today. It also makes the different programs rather easy to compare against each other, at least on a superficial level. It should be noted that the list also includes cancelled programmes, like CAPA / Sterling Airlines, allowing them to be used for comparison.

As previously mentioned the early adoption of MPL regulations was very slow as only 30 states had adopted MPL regulations in 2010 - four years after the concepts approval. At the same time, just over 7% of the ICAO contracting states had approved training organisations to conduct MPL courses and only 12 courses were up and running. More recent data reveal a different reality though and the MPL seem to have taken a stronger hold on the airline pilot training industry. Today the numbers show that 52 states have adopted the MPL regulations and that there are now 22 active MPL courses with a few more expected to be launched soon (Romero, 2013).

Another comparable number is the number of enrolled MPL students. In September 2011 there were 399 MPL graduates and 1671 MPL students. In May 2012 the same figures were 606 MPL graduates and 1872 MPL students. The most recent data is from November 2013 and states 785 MPL graduates along with 2330 MPL students. Together, all of these numbers indicates that both the number of graduates and states who have adopted MPL regulations have almost doubled in the last three years and Harms (2013) stated in a personal conversation that the projected number of MPL graduates and programmes will continue to grow. "*This train cannot be stopped anymore. The results are too good"*. An updated course tracker is expected in 2014 according to Dieter Harms.

## 7. CRITICAL REVIEW AND ANALYSIS OF THE MPL

With the history, origin and early development of MPL having been outlined, the focus will now turn towards a more in-depth critical review and commentary on the continuing development of the MPL. To properly understand any discussion and conclusion presented in the final sections, the building blocks of which the license and its related discussions are based upon will initially be reviewed.

### 7.1 - Previous lack of research – or not?

Although proponents of the MPL has claimed otherwise there seem to be no evidence that the MPL concept was explored, prepared and implemented with the support of any scientific study, a matter that was debated both before and after the MPL became an approved way of training. As already mentioned, resistance was faced due to the significant reduction in actual flying hours. A common comparison and initially often suggested alternative approach, mainly from associations doubting the MPL concept, was the way extended-range twin-engine operations performance standards (ETOPS) were developed. This was done with a data-driven approach through several phases, including extensive research and decades of experience which initially resulted in a 231-page report that took two and a half years to put together (Reich, 2003). In addition, the time frame between the submission of the research results with the final proposals and the implementation was long to fully review and refine the content. Before publication of the final regulations the document existed in the form of a notice of proposed rulemaking (NPRM) and was open to public review and comment. This was also an opportunity for the airline industry to make formal comments to the regulators who later reviewed these comments for inclusion (or not) into the final regulations. ALPA was one example of an association suggesting that the same approach should be used when implementing the MPL and stated *"ALPA believes that a data-driven approach is necessary to ensure that MPL candidates will meet or exceed the standards currently required in traditional training methodologies. This data-driven approach has been successfully applied to other certification endeavours such as extended twin-engine operations (ETOPS)"* (ALPA, 2008).

The ECA stated together with IFALPA already in 2005 their surprise at the expressed urgency of the MPL implementation, later also referring to the ETOPS-example, and argued that any modifications to existing proven training and licensing system should be based upon risk analysis reports and scientific impact assessment (ECA & IFALPA, 2005, p.1.). In 2006 a new position paper by the ECA, stating the very same argument, provided the view that their expressed concerns were not taken into account by ICAO during the development, at least not in a way that publically addressed their questions or involved the organisations representing the interest of pilots (ECA, 2006 p.1.).

Also in 2005 the belief of lacking research was shared and argued by Dahlstrom who stated *"The MPL has so far not been presented in the aviation regulatory and industry organisations with any references to published research, either regarding preparation of the proposal, effects of the introduction or follow-up on the success and consequences of the training when it is in place"* (Dahlstrom, 2005, p.14). In spite of extensive investigation Dahlstrom had still not found any references to relevant published research at the beginning of 2007 and in one way confirmed a theory of an existing gap between research and basic civil aviation training (Dahlstrom, 2007). Instead, research in aviation has primarily been concerned with technological development and even though research on human performance proved early on to be of vital importance for safe and efficient flight, it has generally been initiated as the result of adverse consequences of technological development rather that in conjunction with it (Dahlstrom, 2007).

In 2011 a Master's thesis with the topic *"Can I trust you with my plane?"* was published that aimed to study possible effects on crew functioning as a result of the expressed scepticism towards the MPL and in addition perhaps even towards the license holders (Mikhailov, 2011). Here as well, the lack of research is stated as one of the initiatives behind the study; "*This is especially important to study because the proposal for the MPL seems to be done without any reference to research or open acknowledgement of research community in aiding the design of the proposal itself."* Mikhailov (2011) also points out that this question will become even more salient based on an IATA statement from 2009 that read *"by 2015 it is intended to have the majority of the world's Ab-Initio airline co-pilots trained through the MPL curriculum"*. The results of the study regarding crew functioning are further covered beneath another topic in the report.

However, there is another version or perspective about the MPL background when being compared to military aviation training that the authors have found only limited published material on. IATA (2011, p.6) states that "*the MPL is not revolutionary; it utilises training processes established in the military for many decades",* but this did not provide much information. Instead, the following interpretation is primarily provided through the many conversations and interviews that have been made throughout the creation of this report.

Traditionally, military aviation has been at the forefront of technological development and has also led the way with research projects covering many aspects of human performance (Dahlstrom, 2007). Military aviation training may thus be of relevance also when it comes to the development of the MPL. At an IATA ITQI conference in 2013 about how to improve training provision, the MPL was one of the main topics. The speakers presenting on the MPL were all proponents of the license, but what was interesting were the reactions made by many of the attendees when the MPL was presented as a still relatively new way of training (Harms, 2013, and Kruse and Brändli, 2013). Their reactions were unfortunately never raised as a question at this time, but evolved as a form of background humming both during presentations and in the intermissions saying *"What's so innovative with this?", "This has already been done for years", "This is exactly how we perform training in the military"*, to mention some comments.

During a personal conversation with the executive vice president of FlightPath International, Jonathan Kordich (2013), a similar statement in a way proved this background humming to be of more relevance. FlightPath International delivers MPL training to Ethiopian Airlines in Africa and began designing their program eight years ago from scratch, using their own flight training experience and the ICAO MPL mandate curriculum scheme as a foundation (Kordich, 2013). Kordich, today an aeronautical engineer, had previously been working with the Canadian Air Force for more than fifteen years and said *"When we designed our program I realised I had seen this training before although it was considered new. The more engaged I got the more comparable it became – this was almost exactly how we trained our pilots in the Air Force"* (Kordich, 2013).

This theory was later also confirmed by military training providers in Sweden (Ziese, 2013). Based on the expressed statements and opinions it could be argued to some extent that there is a form of empirically performed research, which is based on experience and has proven that a similar concept can function and produce good results. It should be mentioned that this perception, however, does not take into account in what way civil aviation training can be fairly compared to its military counterpart. The authors have also attempted to briefly answer this question and statements points at that although the final objective is significantly different the competency-based approach to training is comparable in some but not all aspects (Ziese, 2013 and Kordich, 2013). The lack of academic research still appears to remain a fact, in particular when in regards to using CBT as a proven concept, but with a new context and a different training outcome as target. This aspect is more thoroughly discussed when reviewing competency-based training.

## 7.2 - The paradigm shift to Competency Based Training

### 7.2.1 – A perspective on aviation safety

IATA recently stated that air travel continues to be the safest means of transportation (IATA, 2013). This view can be reinforced and confirmed by reviewing available statistics for all forms of passenger transport on the North American Transportation Statistics database (NATS, 2013). According to the National Safety Council in the United States the lifetime odds of dying in an air or space transport accident is 1 in 7229 and includes considerably more dangerous non-commercial air travel (NSC, 2013). To put it in perspective, the odds of an aircraft accident are in terms of risk preceded by firearms accidently discharging and followed by excessive exposure to natural heat. The comparison that is often made to the risk of dying as a car occupant is 1 in 415. Another perspective was given by a professor in statistics, Arnold Barnett, who showed that the death risk in the last five years for aircraft passengers in the United Stated has been one in 45 million flights. In other words, "*Flying has become so reliable that a traveller could fly every day for 123,000 years before being in a fatal crash*" (Barnett, 2013).

Aviation is an accident-intolerant industry and although the industry has had a focus on improving safety since its dawn and continue to show a positive trend, unfortunately accidents still occur (ICAO, 2013). Comparable figures can be found in the ICAO safety report that between 2006 and 2011 the accident rate was 4.1 per one million at its lowest (2006, 2009) and 4.8 at its highest (2008) (ICAO, 2013). The same figure was significantly lower at 3.2 in 2012. Most recent data presented in January 2014 point towards that 2013 again broke the industry's safety record in number of fatalities from 2012, hopefully showing a start of an increasingly positive trend (ICAO, 2013, 2014 and IATA, 2013, p.7.). The aim of reducing the accident rate further is continually challenged by the dubious notions of human error being recognised as a contributing element in 60-80% of the aviation incidents and accidents (Shappel et al., 2006, p. 5 and IATA, 2013). Based on an analysis of accident data covering the 2006-2011 time period ICAO have identified three high-risk accident occurrence categories (ICAO, 2013);

> *1. Runway safety-related events*
> *(i.e. abnormal runway contact, bird strike, ground collision, ground handling, loss of control on ground, collision with obstacle, undershoot/overshoot, runway excursion/incursion)*
> *2. Loss of control in-flight (LOC-I)*
> *3. Controlled flight into terrain (C-FIT)*

Although statistics of accidents and hull losses are two methods to measure safety, these should not be used as a basis to make judgments on safety in total. From the gathered data, however, it can be argued that the human-machine as well as the human-human interface remains a crucial part in maintaining and improving the safety levels of modern aviation. As mentioned the realization of that not enough had been done to address Human Factors issues was one of the initiatives behind the MPL already when discussions began. In addition, and as stated by Dieter Harms most recently in Russia in November 2013; *"In view of the expected growth of global civil aviation we cannot allow for the accident rates to stay the same. We need further reduction"* (Harms, 2013).

The constant development in the design and reliability of modern aircrafts and a rapidly changing operational environment prompted the need to develop a new paradigm for competency-based training and assessment of airline pilots, which then had to be included in an attempt to modernise training (Harms, 2013). Based on the earlier statements it can be discussed if this in fact was a new approach to aviation training in general, or to civil aviation training alone. Initially, however, it led to a strategic industry review of pilot training to indentify the skills and competencies required for a safe completion of every flight regardless of what situation might occur along its path. This was done by analysing the tasks performed by crews operating a modern multi-crew aircraft in all phases of flight (Harms, 2013). But the discussion initially also raised other questions in terms of how not only competence is defined, but also how experience is defined in aviation today.

### 7.2.2 – Defining experience – does more hours equal higher competency?

The Oxford dictionary definition of "experience" is *"the knowledge or skill acquired by a period of practical experience of something, especially that gained in a particular profession", or "the process of doing and seeing things and of having things happen to you."* Simply interpreted the first part would suggest that with enough time and practice anyone would become experienced in a profession regardless of field of choice. A machine operator performing a similar task every day for a long period of time, possessing all the knowledge related to the equipment and being able to perform relevant operating tasks without much effort should be, based on the definition, considered experienced. The second part, however, suggests that a view of the operator as experienced would be reinforced if the machine broke down occasionally and the operator has been forced to handle a number of challenging events. A comparison can be made to aviation where the most commonly used measurement of experience for a long time has been the number of accumulated flying hours, based on the assumption that the more flying hours a pilot has gained the more experienced he or she would be. It is true that the hours may be judged differently based on how they were gathered, for example regarding different aircraft types or different geographic locations, but in general it is the total amount that counts. A quote that in one way defines experience and at the same time describes a problem with using flying hours to measure it reads; *"Experience is that marvellous thing that enables you to recognise a mistake when you make it again"* (Jones, n.d.)

With that being said, this method of measurement becomes interesting to discuss considering the technological development and increased system safety that significantly has changed the way a pilot operates a modern aircraft today. During the creation of this report there have been countless conversations and encounters with pilots, who together hold hundreds of years of experience and hundreds of thousands of flying hours, resulting in one fact becoming clear; although occasional challenges had occurred for these pilots, related to technology or weather for instance, very few of them had faced a situation that critically jeopardised the safety of the flight. Based on the ICAO statistics of accidents earlier mentioned there are of course those who have, but they are indeed few in numbers, thus supporting that the majority of initiated flights is completed without large anomalies. Most commercial airlines also use standard operational procedures, including checklists and standardised communications, measures which are universally recognised as promoting safe aviation operations and minimising risk (ICAO, 2000). In this operationally controlled and consistent environment it would be reasonable to question if 10 000 flying hours actually equals 10 000 hours of valuable gained experience or perhaps instead one valuable hour gained 10 000 times. The same perspective described with different words was presented by John Bent (2011) at an APATS conference when he quoted an experienced aviator saying; "*Never let a man tell you he has 20 years of experience when what he really has is one year of experience repeated 20 times".*

There are others with the opinion that the experience level of the pilots flying in terms of hours and/or years indeed has a direct impact on the safety of the flight. Cooke (2011) argues that *"As a pilot becomes more experienced, he thinks less about the "stick and throttle" part of the job and becomes more of a tactical or critical problem solver"* and that *"the ability to handle both the technical and strategic aspects of the job comes from years and years of experience".* The technical term that this ability would reference to is "metacognition" – defined as the process of knowing about knowing and the inferences is that the time it would take to develop such mental processing abilities can be up to 20 to 25 years (Cooke, 2011). It should be noted that this statement did not seem to relate to any published research, but similar views are often voiced in other contexts as well.

A comparable theory or statement is the one regarding the "10 000 hour rule" (Gladwell, 2013). This started out as a study of perceptual structures perceived by experienced versus inexperienced chess players and was initiated over forty years ago. Two scientists named William Chase and Herbert Simon drew a famous conclusion in the study of expertise saying: *"There are no instant experts in chess—certainly no instant masters or grandmasters. There appears not to be on record any case where a person reached grandmaster level with less than about a decade's intense preoccupation with the game. We would estimate, very roughly, that a master has spent perhaps 10,000 to 50,000 hours staring at chess positions…"* Gladwell (2013) states that in the years that followed, an entire field within psychology grew up devoted to elaborating Simon and Chase's observation and time and time again researchers reached the same conclusion saying; – *"it takes **a lot** of practice to be good at complex tasks".* The research also raised the question about any connection between innate talent and exceptional performance initially stating that *"no one succeeds at a high level without innate talent"* (Gladwell, 2013). However, the research revealed a different reality as the closer psychologists looked at careers of the gifted, the smaller the role of talent seemed to play and it was replaced with emphasis on relevant preparation and training as key factors for success. The theory was also criticised and interpreted by some as that it was possible for anyone who put in the 10 000 hours to achieve a level of proficiency equal to that of a professional *"regardless of that person's natural aptitude"* (Szalavitz, 2013). The response is that natural aptitude may indeed matter, especially for the time required to develop skills and learn the necessary knowledge. This is expressed as *"achievement is talent plus preparation"* (Gladwell, 2013). "*Nobody walks into an operating room, straight out of a surgical rotation, and does world-class neurosurgery. And secondly, the amount of practice necessary for exceptional performance is so extensive that people who end up on top need help"* (Gladwell, 2013). This would support a theory of that training provides a foundation of vital importance for a proficient professional, supported by individual aptitude and the experience of those providing the training itself. Gladwell (2013) also recognise that the theory is not likely applicable to every domain as there will always be exceptions. The conclusion, however, reads; *"In cognitively demanding fields, there are no naturals".*

Beneath this topic two words often mentioned in the aviation industry is "experience and knowledge", in that specific order initially providing an indication of the words individual weighting (Dahlstrom, 2013). The fact that they are separated could be considered illogical as logically knowledge is to a large extent gained through experience. Basic Human Factors literature states that when using experience to solve a problem, you fetch the solution in the memory, in other words using knowledge. In addition, it would seem reasonable to implicitly divide knowledge into practical knowledge, considered as experience, and theoretical/academic knowledge. In the world of aviation Dahlstrom (2013) argues that the first one mentioned always has been the one considered relevant, based on reasons such as risk taking, the type of personalities aiming for a piloting career, strong tradition of practitioner identity and the lack of academic research in many areas of aviation (especially regarding learning and training). As mentioned the role of a pilot has significantly changed, which makes it important to discuss if this view still is as relevant as it perhaps used to be. Experience does not necessary provide great knowledge in aviation today (Dahlstrom, 2013). This would indicate that the demands to assimilate knowledge through alternative methods, such as education and training, have increased. Not surprisingly this would bring additional costs that the airlines do not want. It may potentially also bring a foreign mindset to pilots as, previously mentioned, key operator decision makers sometimes state *"As we meet regulatory requirements, why should we add more training?"* (IATA, 2011) This paradox provides a necessary understanding of experience and knowledge when aiming to understand the view on training and qualification in the aviation industry.

In March 2010 the global head of MPL and Ab-Initio initiatives at CAE, Gary Morrison, brought attention to judgment as a capability often related to experience. Morrison (2010) stated that after more than a hundred years of aviation the same question is still debated; *"Does total flight time translate into experience and judgment?"* A quote that provides a perspective on why the question is difficult to answer and is still discussed reads, *"Good judgment comes from experience, and experience comes from bad judgment"* (Jones, n.d.) Vittone (2010) argues that *"experience* means *nothing, judgment is everything"* and defends his statement with two examples of well known aviation accidents. The name "Chesley Sullenberger" has since 15 January 2009 been associated with images of *"competence and heroic calm under enormous pressure"* (Vittone, 2010). Shortly after a departure from La Guardia airport, US Airways flight 1549 suffered a total failure on both engines as a result of multiple bird strikes. The passengers aboard could not have asked for a better pilot that morning when the crew, with Captain Sullenberger in command, made a successful emergency landing on the Hudson River without compromising a single life of the 155 passengers. Captain Sullenberger was a flight instructor who also developed vital flight safety programs and had in his career gathered an impressive number of safe flying hours that indeed made him qualified to the title "experienced" in aviation terms.

When instead mentioning the perhaps not equally familiar name "Jacob Van Zanten", an entirely different image appears. Van Zanten was also a flight instructor, a leading figure in safety and had accumulated a significant amount of flying hours, also earning him the title "experienced". He inspired admiration and respect from his peers and Vittone (2010) describes him as *"quite literally the model pilot of his airline"*. With that being said, the passengers aboard KLM flight 4805 could not have asked for a better pilot either. Despite the obvious similarities between these two men, on 27 March 1977 Van Zanten was part of the worst airline disaster in aviation history in terms of the number of casualties. Seconds after being safely parked on a taxiway the aircraft, a Boeing 747 carrying 248 people, entered conditions of almost no visibility; only to seconds later collide with Pan Am flight 1736, another 747 carrying 396 people. While there have been many different theories as to why the throttle of the KLM 747 was advanced without takeoff clearance on that foggy runway at Tenerife airport, there has never been any dispute about that Van Zanten was the one who made the decision to do so. Out of the 644 persons involved only 61 survived. *"With decades of experience and training telling him "no", Van Zanten's judgment failed him (and 582 others) and he made a mistake a rookie would not dare to"* (Vittone, 2010).

There are those who speculate that Van Zanten was a victim of his own success and that pressure to keep an excellent on-time record or ego, created by previous success, led him to believe he knew best. Vittone's (2010) point of view was *"is is often experience that foils a leader's judgment"* and concludes his statement with "*as Van Zanten learned just seconds before he perished, previous success does not equal future success. At the end of the day, judgment beats experience every time."*

As noted there are several different opinions on experience, ranging from one extreme to another. What is perhaps more interesting is how today's regulators recognises the issue of interpreting experience and what actions have been taken in response. In 2010 at an ICAO conference about the next generation of aviators, Gary Morrison raised the discussion about flying hours and in addition stated that *"Some recent comparatives have shown well designed programs have produced pilots with one-third the amount of flight time of pilots obtaining the ATP license but indeed have 3 to 4 times the amount of "hands on" actual manoeuvres experience."* Shortly thereafter he asked *"So if it is not total flying hours or number of manoeuvres that measure the ability of the pilot, then what is the answer and how do we define it?"* This question has also been asked to pilots, regulators and to both proponents and opponents of the MPL throughout the creation of this report in an attempt to gather perspectives. Not surprisingly it resulted in different answers, not on only proving the question to be heavily subjective but also explaining why it is still being debated after more decades of discussion on this topic.

Morrison (2010) continued his statement by arguing that present accident rates for commercial jets since 2000 and the five year running average had levelled off and said "*We are part of an industry that has established an expectation of safety in the travelling public*." The regulatory responses to safety so far had often been to increase the prescriptive hourly requirements, the required manoeuvres and the testing processes necessary for qualification *"and yet, many believe that adding more prescriptive requirements does little to **confirm** that a trainee has obtained the knowledge and mastered the skills"* (Morrison, 2010)

Despite that last quote, on 10 July 2013 the FAA in the United States made final a rule that required all commercial airline pilots hired by U.S. carriers to have at least 1,500 hours of flight time. This rule went into effect on 1 August (Maxon, 2013). The new requirements were said to be adopted in reaction to the Colgan Air accident in 2009 in which both the captain and first officer were relatively inexperienced. FAA administrator Michael Huerta stated in the agency's announcement; *"The rule gives first officers a stronger foundation of aeronautical knowledge and experience before they fly for an air carrier."* Before, the requirement was a commercial pilot license with a minimum of 250 hours. The new rule now raised the minimum to the ATP license and 1500 hours. In addition, the FAA also required a pilot to have at least 1000 hours as an airline first officer before flying as a captain. These new rules do allow some exceptions for a "restricted privileges" ATP certificate, such as for pilots with 750 hours in the military, for college graduates with an associated degree in aviation and 1,250 hours and for 21-year-old pilots who already accumulated 1,500 hours. The minimum age for an ATP license is 23 years (Maxon, 2013).

These rules were, just as the ETOPS-proposal, preceded by a NPRM – notice of proposed rulemaking, allowing the airline industry to comment on the rules and raise any concerns to be taken into consideration before publishing a final version. The NPRM came on 27 February 2012 and less than a month later IAFTP (International Association of Flight Training Professionals) issued a response that clearly recognised the rules to have an impact on global pilot training industry (IAFTP, 2012). Again, the correlation between flying hours and experience was questioned as John Bent, an IAFTP founder and member of the IAFTP advisory committee shared his personal opinions;

> *The main regulatory response to the shocking fatal Colgan accident should be to legislate 1,500 flight hours of minimum 'experience' for entry to all Part 121 operations (public transport aircraft with over 19 seats), yet:*
>
> *- Both Colgan pilots had amassed well in excess of 1,500 flight hours of flight 'experience' so how can this factor be related to this accident?*
> *- Experience expressed as total flight hours in the Law (111-216) and in the NPRM is an ineffective metric.*
> *- But experience expressed as pilot(s) knowledge and skill (obtained through training and operations) was a valid shortcoming in this accident crew, yet this is not a major emphasis of the law or NPRM.*
> *- Outside the USA, many States have been accepting pilots with only 200-hours of well structured training, directly into the right seat of major carriers for decades."*

Bent (IAFTP, 2012) also ended his statements by referring to the MPL, not currently adopted in the United States, and argued that the eventual adoption may impact the ability of an ATO to benefit from the higher quality output of MPL due to student reluctance to have to find even more hours later. As the rule was based on current safety concerns he also suggested that there are some real solutions available and said;

> *"the prime target of all commercial aviation industry stakeholders should be more relevant effective quality training (instead of prescriptive flight hour experience-*

*gates), and this should be instigated throughout the aviation industry as ICAO is attempting to guide."*

Another quite similar statement came from the Senior Vice President, Operations and Safety, at the Regional Airline Association (RAA), Scott Foose (2012);

> "*If safety is the goal, then experience is part of the solution. It is my opinion and the opinion of many other industry veterans that "flight time" does not equal "experience."…We acknowledge the need for prescriptive standards but the FAA and NTSB have each recognised that flight time is not a good indication of experience or safety. Let me put it simply: four hours of fair weather sightseeing in a Skyhawk has minimal benefit as compared to four hours in a modern simulator with a highly trained, professional flight instructor…Our concern is that if we do not take advantage of this opportunity, we will be encouraging the next generation of pilots to merely build hours, when what we really need is experience in our cockpits. Again, flight time is not the same thing as experience."*

The question that remains is if these statements can provide any conclusion about how experienced is or should be defined in the aviation industry and how it relates to competency. Sadly, the only logical conclusion seems to be that there is not a unified definition available at this time. One interpretation is however that there indeed is a changing mindset regarding how alternative training methods can complement flying hours in defining competence. One such complement could theoretically be proven competence. The FAA seems to have taken some consideration to training methods with the new hour-based rule, as requirements in terms of hours are less if you were trained in the military (750 hours), a college graduate with an associated degree in aviation (1250 hours) or graduate of a baccalaureate aviation degree program (1000 hours). Bent (IAFTP, 2012) has been one of many proposing that a better solution would be competency-based training and assessment as done in an MPL training programme. This was also the position argued by Morrison (2010), who promoted it by saying: "*Competency-based training is a means of training that places emphasis on achieving benchmarked standards of performance; more precisely, training that focuses on what a person will actually be required to do in the workplace after completing a program of training."* With that said, there is a need to review how this competency-based training is actually intended to be performed within the MPL framework.

### 7.2.3 – Competency in a civil aviation training context

To review competency based training it is probably in order to initially also define competence when using the term in relation to MPL training. ICAO has defined competency as *"the combination of Knowledge, Skills and Attitudes (KSAs) required to perform a task to a prescribed standard under a certain condition"* (IATA, 2011).

Based on what was claimed to be industry-wide research, a set of eight Pilot Core Competencies have been identified and defined in harmonisation by IATA, ICAO and IFALPA (IATA, 2011). These competencies are said to cover all phases of a pilot's career, encompassing selection, ab-initio training, assessment for skill test and recurrent evaluation and training. Harms (2013) has also presented them as a group of related behaviours, based on job requirements, which describe how to operate a modern multi-crew transport airplane safely, effectively and efficiently and what proficient performance in all phases of flight operation looks like. The competencies are defined as:

1. Application of Procedures, **AOP**
   *Application of procedures according to published operating instructions.*

2. Communication, **COM**
   *Demonstrates effective use of language and responsive feedback. Plans are stated and ambiguities resolved.*

3. Flight Management, Guidance and Automation, **FMA**
   *Proficient and appropriate use of flight management, guidance and automation including transitions between modes. Monitoring, mode awareness and vigilance. Flexibility needed to change from one mode to another.*

4. Manual Aircraft Control, **MAC**
   *Maintains control of the aircraft in order to assure the successful outcome of a procedure or manoeuvre.*

5. Leadership and Teamwork, **LTW**
   *Uses appropriate authority to ensure focus on the task and crewmember concerns. Supports others in completing tasks.*

6. Problem Solving and Decision Making, **PSD**
   *Detects deviations from the desired state, evaluates problems, identifies risk, considers alternatives and selects the best course of action. Continuously reviews progress and adjusts plans*.

7. Situation Awareness, **SAW**
   *Awareness of the aircraft state in its environment projects and anticipates changes.*

8. Workload Management, **WLM**
   *Prioritises delegates and receives assistance to maximise focus on the task. Continuously monitors the flight progress.*

When the cadet has completed the MPL training programme, the following competency units should be possessed by the cadet (ICAO, 2006):

- *Apply threat and error management principles*
- *Perform ground and pre-flight operation*
- *Perform take-off*
- *Perform climb*
- *Perform cruise*
- *Perform descent*
- *Perform approach*
- *Perform landing*
- *Perform after-landing and aircraft post-flight operation*

To be able to critically review competency-based training it is also necessary to first understand how this approach is described, if it is being delivered as originally intended in an MPL training environment.

### 7.2.4 – Competency-based training as intended with the MPL

The following description of how competency-based training should be performed in an MPL course was provided by Dieter Harms at the IATA ITQI conference held in London 5-6 June 2013. Harms has been widely seen as "the father of the MPL", as he was one of its first promoters and acted as senior advisor to ICAO during the creation of the license.

Harms (2013) stated that the shift when transferring from task-based training to competency-based training is that it will move training and performance assessment to a new dimension that will better prepare the flight crews for their profession. If successful the training is said to change from being reactive, for instance in terms of training for old accidents to avoid them from happening again, to being proactive and instead contribute to the prevention of new and not yet experienced accidents (Harms, 2013).

In MPL-training the emphasis is on the development of the previously described core competencies and their behaviour indicators, on top of performing the different tasks to the prescribed standards. The prescribed standards being those described in the training providers' operations manual e.g. a training target such as altitude ±200 feet or speed ±10 knots. The performance of the training tasks is then used to develop and reinforce the core competencies by evaluating competency-specific behavioural indicators. The behavioural indicators that the instructors should look for in the students' performances in order to evaluate them can be seen in APPENDIX 4. If the competencies are developed correctly the training is said to assist the flight crew to handle any unforeseen and untrained event. However, the unforeseen as referred to here is not to be mistaken for the unexpected. An unexpected event could be a result following insufficient threat- and error management (to be described in-depth later), e.g. thunderstorms at the intended destination, not noticed before departure, requiring the flight to divert to an alternate. Instead, the resilient and repeatable, continuous application of the core competencies during a flight should enable the flight crew to handle any suite of unforeseen abnormal or emergency events.

The MPL competency-based training does not rely on a number of static lesson plans with a prescribed fixed amount of training time. The beliefs were previously that once “time requirements” were fulfilled the training objectives had been met, this being proven by a successfully passed check flight or skill test. In fact, in a competency-based training accumulated hour requirements are of secondary importance. The training focuses on the training outcome rather than training time. Training hours are replaced by defined performance criteria, which must be measurable both regarding training input and training output. Training output addresses the question of “what” is to be achieved. Training input raises the question of “how” a certain output can be assured and which “KSAs” (Knowledge, Skills, and Attitudes) that needs to be focused on in order to enable the desired performance. The design of a competency-based training course therefore requires detailed knowledge on training methodology and assessment, which may create some initial challenges for the training provider. Without harmonisation within the organisation the student will face a subjective grading since different instructors then will have their own thoughts about what is a correctly applied competence and how it is expressed. The industry has therefore also developed different assessment matrixes, but each individual training provider will need to ensure its functionality within their organisation. An example of the matrix can be seen in figure 7.2.4 below.

| OUTPUT | | | | INPUT (TEM) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (Competency Units) | AOP | COM | FMA | MAC | LTW | PSD | SAW | WLM | KNO |
| Gnd.Ops. | | | | | | | | | |
| Take Off | | | | | | | | | |
| Climb | | G | R | A | D | E | S | | |
| Cruise | | | | | | | | | |
| Descent | | | | | | | | | |
| Approach | | | | | | | | | |
| Landing | | | | | | | | | |
| | NORM | NORM | NORM | NORM | NORM | NORM | NORM | NORM | NORM |
| Ground Ops | | | | | | | | | |

Observed performance compared with norm

*Fig 7.2.4 – Example of the competency-based training assessment matrix (Source: Harms, 2013)*

Horizontally listed are the core competencies described by using the abbreviations mentioned earlier. It should be noticed that in this table there are nine and not eight competencies, as previously described. The ninth, not at this time considered to be a core competency, is knowledge. For each task knowledge is required in order to be able to understand and perform the task theoretically perfect. Normally this is checked through questioning at a briefing before a training session in order for the instructor to ensure that the student has the knowledge to correctly evaluate insufficient performance. Vertically are examples of tasks, divided into phases of flight, which in content may differ depending on the aim of the training session and the outcome goal. These also counts for the competency units of which the MPL student is supposed to have acquired at the end of the training. In addition to a statement or evaluation on how a task was performed in relation to the prescribed standard, every single lesson grade sheet contains a statement on the quality of the application of the core competencies via grading of their associated behavioural indicators. In other words, when a student's task performance is below the predefined NORM, he/she should be told why this has happened and which competency category was related. The student will then also learn which competencies that were misapplied or could have been prioritised differently. This model could also be used as a data driven approach by collecting data for student performance and instructor performance and then use this to adapt the course content, making it a helpful tool during a constant development of an MPL program. In other words it can potentially show observed performance compared with desired performance.

### 7.2.5 – Threat- and error management

One of the authors has previously provided a report for the Swedish Civil Aviation Authority (SCAA) on TEM, CRM and assessment of CRM skills. Contents of that report have been used for this report and the review of TEM can be found in APPENDIX 5. Below is a more general description of TEM and its links to the MPL.

Harms (2013) argue that the ongoing application of the core competencies during a flight can also be referred to as Threat- and Error Management (TEM). IATA (2011) states that TEM is the competency that overarches all of the other ones in MPL training. TEM-items should be embedded in every training session within the MPL syllabus. The Flight Safety Foundation describes TEM as a systems approach to aviation safety. TEM was developed by Human Factors researchers at the University of Texas and is claimed to provide aviation professionals with a risk management lexicon that supports a positive safety culture. Maurino (2005) initially stated that TEM is a framework intended to practically integrate Human Factors into aviation operations. He also stated that it is not a revolutionary concept but instead one that has gradually evolved. The development of TEM is said to be based on the constant drive to improve the margins of safety in aviation operations. With collective industry experience the TEM-model could achieve this by a practical integration of Human Factors knowledge. Also according to Maurino (2005), the industry recognised that past studies and operational consideration of human performance in aviation had largely overlooked the most important factors influencing human performance in dynamic work environments. This refers to the interaction between people and the operational context (for instance organisational, regulatory and environmental factors) within which people complete their operational duties. The recognition of how operational context influence human performance further led to the conclusion that study and consideration of human performance in aviation operations must not be an end in itself. Maurino (2005) states; *"In regard to the improvement of margins of safety in aviation operations, the study and consideration of human performance without context address only part of a larger issue."*

As Human Factors issues was one of the driving forces behind the MPL, TEM proved to be a way to incorporate Human Factors in aviation training. The section head of Human Factors at the Australian CAA, Ian Banks (2011, p.4) presents TEM as a framework that *"assists in understanding, from an operational perspective, the inter-relationship between safety and human performance in dynamic and challenging operational contexts."* That last sentence also provides the ICAO definition of TEM. Furthermore, Maurino (2005) argue that the TEM framework focuses simultaneously on the operational context and the people undertaking operational duties in such context, and that the framework is descriptive, practical and diagnostic of both human and system performance. It is said to be descriptive because it captures human and system performance in the normal operational context, resulting in realistic descriptions. It is said to be practical as pilots may use it intuitively and diagnostic because it allows quantifying the complexities of the operational context in relation to human performance. Banks (2011) state that the model assumes a sequential handling of threats and errors by the pilot – argued to generally be the case in airline operations. A pilot's activity consists in many ways of managing threats and errors where "*the real importance isn't that they occur in normal operations but how they are being managed"* (Banks, 2011).

A fundamental premise of TEM is that threats and errors are unavoidable components of complex operational contexts, and that is why TEM advocates management as opposed to avoidance or elimination. Banks (2011) argues that one common false assumption is that errors and violations are limited to incidents and accidents. By referring to recent data from flight operations, such as line operating safety audits (LOSA), there are indications that errors and violations are quite common in flight operations. The LOSA database, from originators of the TEM-model at the University of Texas, shows that in around 60% of the flights at least one error or violation was observed, the average per flight being 1.5. In addition, a quarter of errors and violations were mismanaged or had consequences (an undesired aircraft state or an additional error). One third of the errors were detected and corrected by the flight crew, but the interestingly findings indicated that 4% were detected and made worse, and over 60% of errors actually remained undetected. Banks (2011) argued that this data should underline the fact that errors are normal in flight operations and that, as such, they are usually not immediately dangerous.

The TEM framework is divided into three basic components – threats, errors and undesired aircraft states (Maurino, 2005). Integrated into the framework is the proposition that threats and errors are part of everyday aviation operations and must be managed by flight crews, since both threats and errors could potentially generate undesired aircraft states. Management of these undesired stated must also be handled by flight crews since they could potentially generate unsafe outcomes. Maurino (2005) argues that undesired state management is an essential component of the TEM framework, considered to be just as important as threat and error management since represents the last opportunity to avoid an unsafe outcome and maintain safety margins in flight operations. For this reason, upset recovery and prevention (UPRT) training has also been incorporated into MPL training.

The Flight Safety Foundation states that today the TEM model is recognised as worldwide best practice by ICAO, IATA, JAA, NATA and IFALPA. TEM training is now also embedded in ICAO SARPs as a part of Flight Crew Licensing requirements. As expressed by Harms (2013) *"TEM is an overarching pilot competency which pervades the whole dynamic process of a flight, or a series of flights, from the very moment the crew meet at the check in counter until the completion of the shutdown checklist at the end of a duty cycle."* The TEM connection to MPL is further reviewed with competency-based training.

### 7.2.6 – Competency-based training reviewed

The competency-based training of MPL is to be built on the instructional systems design process. For that reason it becomes interesting to highlight any critique towards this approach. Finding such critique has been difficult and actually often provided by those who are proponents to the approach and this can provide some perspectives on what to be cautious about when using ISD in MPL training.

Clark (2013) argues that the ISD model is a management tool that makes the creation of learning platforms or learning processes more efficient. The reason for why learning and performance become more effective is simply because the ISD model increases the probability that the courseware will match the training objectives. Furthermore, the training and curriculum can be continuously improved and strengthened through data collection and analysis. The ISD model has been criticised because it is frequently presented in flowchart form, leaving the impression that it is mechanistic and linear in its approach. An example of the model presented in such linear way can be seen in APPENDIX 6. As was earlier explained, the ISD approach not only allows for, but requires continuous evaluation, thus making it a rather exploratory approach. The linear model referred to in APPENDIX 6 could be best used to show its different steps, however, the below model described with the training design better shows its dynamic nature. It has also been criticised for telling the training designers *what* to do – but not *how* to do it. Clark (2013) argues that these arguments are invalid based on that there is a considerable body of educational, learning, and training literature that tells how to perform the various steps in the ISD model. Furthermore, such prescriptive measures would suggest that the ISD attempts to change training from being an art into a science that, if used as directed, would produce predictable and reliable results in learning. According to Clark (2013), designing instruction is both an art and science and thus a good instructional designer uses knowledge and skills as well as expertise based on experience to create quality in training. ICAO (2006) has acknowledged that there are different ISD models that could be equally appropriate to apply in the development of competency-based training. ICAO restricts their view to that the important thing is that the model of choice contains the ISD elements that govern the three basic procedural steps of a needs analysis, design and production, and evaluation.

From this perspective it can be said that understanding how to work with the ISD approach is important before undertaking training development. It is also important not to get caught up with only inward-directed perspectives of incremental training steps and thereby losing focus of the final purpose of the training. A more frequent criticism is that ISD is too time-consuming to be practical in the real world (Clark, 2013). Again, not knowing the basic procedures for building a learning process leads many novices down the wrong path, thereby wasting resources. ISD provides all instructional designers, from novice to expert, a common set of terms and processes to effectively communicate with each other and should theoretically be able to assist in standardising training – a necessity in CBT to be able to use any collected data for evaluation and improvement. Finally, Clark (2013) states that some have been calling the ISD process a model that can be used for a number of outcomes, such as building a house or a web site. However, Clarke responded to this by stating that a true ISD model is limited to instructional outcomes. Whereas MPL training has so far been mainly built on previous experience from ab-initio training there is a far way to go for the full ISD and CBT approach to be implemented.

One possible criticism is that "competency-based training" seems to have become a disturbingly popular term, used by many and often. But it is necessary to ask if those using it actually have understood its true meaning and purpose, and more importantly its potential dangers. The term reappears in many discussions and is used in completely different contexts, even when contained within the framework of basic civil aviation training. Although military training may have applied a CBT-approach to training, possibly with success, for quite some time, it is of interest how this will play out for civilian aviation training. This is particularly important for the MPL. When the context of training is changed the target of the training outcome may also be different. Initially, Harris, Guthric, Hobart and Lundberg (1995, p.9) argue that *"competency-based education and training is mostly being implemented with insufficient debate, analysis and critique."* Pilot organisations, such as ECA and IFALPA, expressed early that part of their resistance towards the license was the unexplained urgency of implementing the MPL concept (ECA & IFALPA, 2005, p.1). As the criticism of lack of research before implementing this new approach to aviation training appears to be true, it is of great interest to outline also if the quote from Harris et al. as per above is true with the MPL and if it poses a threat to the very training itself.

In regards to the concern of training time in actual aircraft being reduced and replaced with simulator time, (see APPENDIX 1 and 2) no material or source can be found on whether or not research on this was done or reviewed when implementing MPL and CBT. Some information on the origins of CBT is provided by ICAO in PANS TRG. However, no effort at all appears to have been made in determining the impact of this change. Instead, the information available indicates merely a conclusion of that since it has worked well in military aviation training it therefore should do so for civilian aviation training. It is this and the fact that CBT makes up the foundation to the MPL training concept that makes a review of CBT so important.

Hodge (2007) argues that the concept of CBT likely has accelerated in development in the US during the 1950s and 1960s, with a peak during the 1970s, by specialists involved in training of personnel in the US armed forces. ICAO (2006) adds that different system engineering methodologies, like the mentioned ISD or systems approach to training (SAT), resulted in an implementation of more modern performance-based training programme designs that spread from the US to Europe during the 1980s and 1990s. As technology has progressed and been applied to different areas of human endeavour, it was recognised that more complex skills were required and that this in turn required a more practical and applied form of education (Harris et al., 1995). Two different paths to education have evolved from this, although remarkably much later in civil aviation than in other areas. The first one is the well experienced and safe path of traditional training, in basic civil aviation training logically referred to as the CPL. The other one, incorporated with these more modern views on educational design but so far less used, is the competency-based approach to training, in aviation training represented by the MPL. Harris et al. (1995) argue that this second approach in particular has developed with, and has had most impact on, vocational education. In a technologically advanced society, the skills needed for work have become more sophisticated at the same time as the availability of unskilled work opportunities have diminished. Furthermore, as technology today continues to be ever more increasingly complex, the importance of measuring the skills needed to control technology validly and reliably has increased (Harris et al., 1995). It is even argued that the idea of CBT is in part an outcome of the challenges associated with technological advancements made in society (Harris et al., 1995). The level of technology in a modern commercial aircraft would arguably be considered complex and from this perspective it actually becomes remarkable, perhaps even surprising, that the CBT-approach has not been attempted within civil aviation training earlier. Scheck (2006) argues that it is not surprising that the initial proposal for the MPL came from Europe, as ab-initio training has a much longer history there. But it is equally surprising that the US still shows doubt and resistance as the concept of CBT appears to have started there. As already mentioned the FAA has not yet approved the MPL as a training method. It can be argued that the complexities associated with a modern aircraft and its implications for the pilot profession should have initiated a discussion on aviation training methodology much earlier, regardless of the more recently stated reasons.

Harris et al. (1995) states that *"CBT has brought together aspects of education that have been partially applied for many years, and placed them in a system that requires at times radical changes in the role of the practitioner, the role of the learner, the availability of the resources, the place of assessment, the process of planning and the time structure of learning courses."* It is still possible to question the very definition of CBT as some now use the term competency-based education (CBE), while arguing that there is a distinct difference between training and education (Harris et al., 1995). For instance, as a part of IFALPAs (2012) philosophy of pilot education, "training" is about developing response structures while "education" is more about developing airmanship. In other words, *"creating a professional pilot requires not only training competency in certain technical and non-technical skills, but also an ongoing education to aid pilots to develop and maintain airmanship skills"* (IFALPA, 2012, p.5).

The most noticeable change at first sight with the MPL, when compared to the CPL, is the reduction of actual flying hours. During the phase of development of the MPL the members of the FCLTP were not unified in how many actual flight hours should be required during training. Scheck (2006) stated that those who came from a managerial background advocated an MPL with very few actual flight hours (60 or less – potentially down to a zero flight hour program), while those with operational backgrounds (e.g. pilots or pilot organisations) insisted on a specified number of actual flight hours (120 or more). Although different today, what then happened instead of a final decision was that the FCLTP let the approved training organisations (ATOs) initially determine the actual breakdown and saw no potential problems with this based on the fact that the MPL training would be performed with the competency-based approach (Scheck, 2006). In other words, the MPL cadet would simply not hold and receive a license unless he or she satisfactory had completed the required training and was deemed competent. The problem is that this statement also contains a challenge; what "deemed competent" means is hard to objectively define. The legacy pilot training and licensing practices are based upon the traditional approach where time, mainly expressed in flying hours, is the unit of progression for pilots on their way to become airline pilots. This is easy to measure and regulate but comes with the obvious drawback that a specific number of hours does not necessarily mean that the training outcome has been achieved. With CBT the unit of progression no longer becomes time, but is replaced with the mastery of specific skills and competencies. Dieter Harms (2013) outlines the differences with this theory; *"…be reminded that the exclusive use of a certain number of exercises or hours is in conflict with competency-based training. The terminal measurement criteria for competency-based training are the sustained attainment of predefined competencies against a predefined norm. The time it takes to reach this goal is of secondary importance."*

The word "competence" as defined by ICAO has been mentioned -*"the combination of Knowledge, Skills and Attitudes (KSAs) required to perform a task to a prescribed standard under a certain condition"* (IATA, 2011). Competence may however need to be more than a definition to be validated and measured as a training outcome. The definition of competency-based training and assessment, also defined by ICAO (2013), is – *"Training and assessment that are characterised by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specific performance standards".* This does unfortunately not provide a much deeper insight. Breaking competency-based training down even further into "competency elements", these are defined as "*an action that constitutes a task that has a triggering event and a terminating event that clearly defines its limits, and an observable outcome"* (ICAO, 2013) or increasingly further again into "competency units", defined as *"a discrete function consisting of a number of competency elements"* (ICAO, 2013). Perhaps not surprisingly there has been a confusing situation as the previously described core competencies occasionally have been mixed up with the competency units. To clarify, the core competencies (i.e. communication, leadership and situational awareness) constitute the elements of continuous TEM, considered an indispensable prerequisite for safe, effective and efficient operation (Harms, 2013). The competency units and their respective sub-elements are instead phases of flight subdivided into observable tasks (i.e. perform take-off, perform cruise and perform landing).

Sullivan (1995) state that there are two key terms associated with CBT in general. The authors believe that these definitions make for an easier understanding of competence and the wanted outcome of CBT. Although similarly named, they are differently defined.

***Skill*** *- A task or group of tasks performed to a specific level of competency or proficiency which often use motor functions and typically require the manipulation of instruments and equipment. Some skills (such as counselling), however, are knowledge- and attitude-based.*

***Competency*** *- A cluster of related knowledge, skills, and attitudes that affects a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development.*

According to Harris et al. (1995) it is possible to identify the specific skills and competencies required for superior performance for any profession. The question of how to do this and by whom these competencies have been identified for use in civil aviation training has been answered in the previous sections. However, the question of validity of the competencies is far more difficult to respond to. This was also a question of mutual recognition at the IATA ITQI conference, since even seven years after the MPL has been implemented, different sets of these core competencies were presented from different training providers while Harms (2013) argued that *"there can only be one set of core competencies."* This is not only likely true and important – this probably has to be settled if the aviation training industry is to take steps towards greater harmonisation and mutual recognition in global training standards, which was one of the foundational goals with the MPL.

Thus still, the first CBT-challenge associated with the MPL is to formulate the exact skills and competencies required to qualify as a fully operational airline co-pilot and potentially future airline captain. The scope of this paper will not intend to question the already described core competencies or its associated behavioural indicators defined by ICAO, IATA and IFALPA, more than in noting that there is limited background data and information on their origins. Suggesting that these identified competencies are the ones that will be considered mutually recognised, what appears to be the real challenge and potential threat with the MPL is instead to figure out how to measure these skills and competencies in an objective and consistent manner and thereby ensuring a globally requested training outcome and quality. This is of crucial importance as the world of aviation calls for more standardised and harmonised pilot training worldwide (Bent, 2013).

A fundamental aspect of the MPL-concept is a high degree of managerial freedom in how to set up the MPL training program. This can be confirmed by comparing the current MPL programmes worldwide which reveals several differences, in particular during phase two and three (i.e. by reviewing APPENDIX 3). Regulators provide the necessary framework within which the training provider then constructs the training program. What is of importance is that skills and competencies have been achieved by the cadets at the end of the training. However, this makes it difficult to know when and how to check that they accomplish training goals along the way. For instance, the "norm" in the earlier provided example of grading matrix is not a universally agreed standard. Instead, it needs to be defined by the head of training together with his training design team for every single task connected to every core competency and then printed in the respective detailed lesson plan and/or grade sheet. A second aspect is the fact that the MPL is airline-dedicated and when procedures and equipment differs between different airlines there is a need for flexibility to ensure optimum training conditions. The required competencies, however, are not airline specific rather but need to be mutually agreed throughout the industry. As stated by Scheck (2006), being too specific in the formulation of the core-competencies might stifle those responsible for training as they to realise the potential benefits of MPL training. On the other hand, it must be ensured that the core-competencies have been properly understood and what they entail, by all parties participating in training, as a prerequisite to be able to identify the specific training tasks they believe to adequately reflect the requirements of the MPL.

Thus, the focus turns towards how competency should be considered achieved - the very essence of CBT. Harris et al. (1995) provides a perspective on this challenge by saying that it is similar to giving meaning to a single piece of a puzzle. Given that three different people are each given a piece of the puzzle coloured blue, each of those persons will also interpret their single piece differently depending on their individual frame of reference. To the first person picturing a mountain scene the piece is perhaps part of a blue sky. To the next who sees a vivid ocean view the piece will be a part of that lively water. And to the last, who perhaps visualises a garden scene with beautiful flowers, the piece provides a part of such a blue flower. The point being that *"there is no way that agreement can be reached among those three until they recognise that they are often using different frames of reference in their analyses and interpretations"* (Harris et al., 1995, p.8). This metaphor is true also for the context of aviation training, as it would be impossible for a training provider in Asia to be able to validate pilots trained in an MPL CBT programme in Europe if the references and norms behind their judgment of competence is completely different – even if they have evaluated the same set of competencies. Not further discussed here is in what way cultural differences will or will not affect the judgment of competencies, as the impact of culture has been discussed in many other areas in the aviation industry. For MPL training, there is a provided framework in PANS TRG intended to be used that theoretically contains the necessary foundation and training tools for harmonisation. The information below has been gathered directly from PANS TRG.

The MPL competency framework consists of competency units, competency elements, performance criteria, evidence and assessment guide and a range of variables. The competency framework for flight crews shall be based on the following competency units:

- *Apply threat and error management principles*
- *Perform ground and pre-flight operation*

- *Perform take-off*
- *Perform climb*
- *Perform cruise*
- *Perform descent*
- *Perform approach*
- *Perform landing*
- *Perform after-landing and aircraft post-flight operation*

There is a need to clarify the terms not already defined above. Performance criteria are simple and evaluative statements on the required outcome of the competency element and a description of the criteria used to judge whether the required level of performance has been achieved. An example of this sourced from PANS TRG can be seen in the image below.

| 3. **PERFORM TAKE-OFF**<br>List of competency elements and performance criteria | | | |
|---|---|---|---|
| **3.0 Recognize and manage potential threats and errors** | | | |
| **3.1 Perform pre-take-off and pre-departure preparation** | | | satisfactory/unsatisfactory |
| 3.1.1 checks and acknowledges line-up clearance | Ops. Manual | PF/PNF | |
| 3.1.2 checks correct runway selection | Ops. Manual | PF/PNF | |
| 3.1.3 confirms validity of performance data | Ops. Manual | PF/PNF | |
| 3.1.4 checks approach sector and runway are clear | Ops. Manual | PF/PNF | |
| 3.1.5 confirms all checklists and take-off preparations completed | Ops. Manual | PF/PNF | |
| 3.1.6 lines up the aircraft on centre line without loosing distance | Ops. Manual | PF | |
| 3.1.7 checks weather on departure sector | Ops. Manual | PF/PNF | |
| 3.1.8 checks runway status and wind | Ops. Manual | PF/PNF | |

*Fig 7.2.6 (1) – Example of competency units, competency elements and performance criteria. Source: PANS TRG*

The range of variables is simply the different conditions (i.e. different weather conditions) under which the competency units must be performed, determined by the licensing authority. The evidence and assessment guide is exactly what it sounds like – a guide that provides detailed information (i.e. tolerances) in the form of evidence that an instructor or an evaluator can use to determine whether a candidate meets the requirements of the competency standard. Another example sourced from PANS TRG of such a guide covering take-off roll can be seen in the image below.

| Element | Evidence | TEM Countermeasures |
|---|---|---|
| Perform take-off roll | ➢ Line-up checks are completed<br>➢ Brakes are released<br>➢ Take-off power is smoothly and fully applied<br>➢ Aeroplane direction is maintained on runway<br>➢ Flight and engine instruments are checked and responded to during the take-off roll | ➢ Aircraft position and settings are verified<br>➢ Airport and taxiway charts are used (if applicable)<br>➢ Clearances are understood and accurately read back<br>➢ Into wind aileron is raised (as applicable to crosswind)<br>➢ Excessive pressure on nose wheel is avoided<br>➢ Yaw is controlled<br>➢ Task fixation is avoided; tasks are effectively prioritized |

*Fig 7.2.6 (2) – Example of an evidence and assessment guide. Source: PANS TRG*

To this, training objectives are added. Each training objective should be comprised by three parts. Firstly the *desired performance* or what the cadet is expected to be able to do at the end of training (or at the end of particular stages of training). Secondly the *performance standard* that must be attained to confirm the cadets' level of competence and thirdly the *conditions* under which the cadet will demonstrate competence. The objectives should also be expressed in terms of measurable performance, in other words what specific results are to be achieved and includes behaviour of the cadet even after training. Every identified task should logically encompass the skills and competencies that should be trained.

Also contained in the assessment guide and of paramount importance is Threat- and Error Management (TEM). PANS TRG state that the licensing authorities shall ensure that TEM competency elements are assessed as an integral part of each of the eight phase-of-flight competency units established for the MPL. IATA (2011) refers to TEM as the "super competency", overarching all crew activities and required to be continuously embedded in MPL training with the KSAs as a TEM generator. TEM as well as its connection to CRM have been presented in general with reference to APPENDIX 5. However, a study and survey made on TEM when incorporated with MPL training indicated that there was some disagreement among the survey population on what tasks adequately reflect the skills and competencies required in proper application of TEM (Scheck, 2006). Since IATA (2011, p.23) state that *"TEM plays a most important role in the process of transferring a novice (ab-initio student) into an expert (Airline First Officer)"* and that *"TEM can be understood by students at a very early stage and practiced throughout the course with increasing success",* the result of this study would need to be addressed with the evolution and continuous improvement of MPL training.

When it then comes to assessing and testing if the competencies have or have not been accomplished, ICAO advocates the use of criterion-referenced tests in the course development. Criterion-referenced evaluation means that a measurement is compared with an *objective standard* and not against another measurement. A contrast would be norm-referenced evaluation where for example cadets are ranked based on their performance in reference to each other and a judgment is based on this comparison. This latter is not recommended with CBT. Again, this *objective standard* has not been found as a published guidance to training providers but is individually decided on and thereby also becomes a potential drawback when aiming towards greater global harmonisation.

The competency evaluation, assessment method and the tests that measure whether or not the training objectives have been achieved require a feedback and quality assurance system to ensure validity and reliability. The assessment matrix earlier presented could if used correctly, together with such a system, be used as a foundation to gather data on both student- and instructor performance. The detailed systems for this needs to be constructed by each training provider in order to ensure organisational harmonisation and operational functionality. Some guidance to the training providers who wish or need to develop such a system was given by Michael Varney at the MPL symposium in Montréal. Stakeholders, airlines, pilot representatives and regulators from all over the world had been asked to weigh different criteria in order to appeal to and be approved by the ones who are intended to use the system. The answers resulted in the following weighting perhaps to be considered in the system design (Varney, 2013):

*10 – Fairness and Accuracy*
*10 – Usability*
*9 – Clarity*
*8 – Continuous Improvement*
*7 – Implementation Risk*
*6 – Data Management*
*6 – Adaptability*
*5 – Ease of Compliance*
*5 – Motivation*

When it comes to tests, PANS TRG states that in order for a test to be considered valid and effective, it has to measure what it sets out to measure. Consequently, a reliable test is one that will obtain consistent results even when administered by different instructors. More precisely, a reliable test will allow several different instructors to individually come up with the same evaluation on the performance of the cadets. This, however, implies that the instructors have clear instructions on how to administer the tests together with precise and unambiguous evaluation and assessment instruments. In order to determine if a cadet meets the standard of performance established in the terminal objectives, mastery tests are used.

It would logically be hard to believe that an instructor could train a cadet to competence if the instructor does not also possess this competence, as well as the pedagogical skill to teach which importance is not to be underestimated. PANS TRG (6.6, p.VIII, 2013) states that *"in competency-based programmes, instructor competencies are made explicit, and instructors have to demonstrate their instructional skills and their knowledge of the subject matter and training course content."* Yes, there are more stringent requirements on instructors participating in MPL training, however, these requirements have been mainly hour based. The instructors have also been identified as the single most important component to success in

MPL training by all of the training providers. In 2012 IFALPA released their guide for training best practices – the IFALPA Pilot Training Standards (IPTS) and their definition of an outstanding instructor is *"one who facilitates a student's development of the required skills and airmanship needed for a pilot's stable and successful lifetime performance"* (IFALPA, 2012, p.23) In a CBT environment it logically would require the instructors to also possess the competencies to train but it was not until May 2013 that instructor competency assessment and evaluation was incorporated with PANS-TRG, almost seven years after the MPL was implemented. Instructor issues and qualification are later reviewed in an own topic together with the MPL experiences.

When summarizing all of the facts and statements the results ends up in a single question – is competency-based training really working? This question was in fact a topic in its own on one of the sessions at the MPL symposium at the ICAO headquarters in December 2013. Based on presentations given by the vice president, pilot schools division at LFT, Dirk Kröger, and the deputy director of flight training standards at the CAFUC, Bai Hongqiu, the answer summarised is "yes". Why the answer is considered "yes" by the training providers is also more thoroughly explained with the section covering MPL experiences. But considering what has been argued above, the question perhaps instead should have been limited to, or at least followed by: "Why is competency-based training working in MPL training as of today?" There is not a single or simple answer to that question. The optimal response would be that CBT is easy to undertake and that the results are immediate and better. This, however, is probably not the complete truth. Other theories presented by the authors include that since the MPL training initially has been limited to training providers with vast experience in ab-initio training, that experience has enabled the training to be completed with at least an equal quality as the traditional path. Perspectives can also be sourced from regulators who state that they do not yet possess all the skills, competencies or have regulation in place to assess the competency in cadets, but that they trust the evaluation made by training providers and the obvious pass- or fail result of the MPL skill test (Hermansson, 2013 and Fox, 2013). Logically, neither one of these theories would validate that competencies have been achieved, merely that the required tasks can be performed to a satisfactory level. In fact, in the earlier mentioned global MPL course tracker (APPENDIX 3) there is even a red box with a small note that reads;

"**NOTE:** The information in this table is unweighted. It does not state to what extent the philosophy of competency-based training is met. It has to be recognized that course length and number of training hours are not meaningful criteria to measure the quality or the success of a competency based training scheme."

*Fig 7.2.6 (3) – Information from the MPL course tracker (Source: Dieter Harms, 2013*)

If interpreted to the extreme, there is perhaps not a single running MPL training programme that has completely adopted CBT but uses a mix between the traditional training path and the new approach, or even completely runs the traditional approach but claims otherwise. The organisational change is a challenge as stated by the head of training at CTC Aviation in the

UK, Brian Haigh, *"The change of emphasis to multi crew focused, competency based training is a challenge that cannot be entered into lightly and is a change that all providers of conventional commercial pilot training will need to consider carefully"* Although only argued in theory, the statements that have been presented here could very well turn this theory into reality.

Harris et al. (1995, p.8) argue that "*an excessively hasty implementation of this system may well destroy its potential benefits and in the process neglect or even destroy valuable holistic aspect of education that have made it the magnificent, self-actualizing process it has been for many throughout the centuries, and that it always should be regardless of whatever form or system is used for its delivery*." This limited study has likely only scratched the surface of potential challenges with CBT when incorporated with civilian aviation training and the MPL. Thus, the authors have no final appropriate answer on how competency should be considered an achieved training objective other than what has been described above, where most of the theories are gathered from the original intentions with MPL training. The research done indicates, however, that the tools necessary to get to a globally harmonised view and validation between states exists within the presented MPL framework. But as the content of this framework is less regulated than its counterpart for traditional training, this becomes both the strength and the weakness with the MPL training and requires more in-depth research. The benefits from a successful MPL CBT programme should result in safer and more competent airline pilots. More specific examples and outcomes of CBT from the worldwide MPL training programmes are discussed in the results and discussion section of this report.

Hodge (2007) argues that although CBT appears to be something given in a particular context, such as with the MPL, it remains an essentially volatile system set within a dynamic context. As the needs of stakeholders change and as research and practice reveal new problems and possibilities, CBT will change and potentially even transform. *"When this occurs the "genetics" of CBT will play a part in the shape it eventually takes"* (Hodge, 2007). With this is mind, if CBT is allowed to transform and evolve in different ways around the world, the view of globally harmonised training standards will likely be harder to reach than it already is. Furthermore, the measurement of success to CBT in civil aviation will likely not be a short-term identification of change in technical and non-technical skills. Instead, and as expressed by Gary Morrison (2013), the long-term measurement of success is most probably a continuous reduction in global accident rates from the result of enhanced safety and more competent pilots – proficient to handle the unforeseen.

## 7.3 – Evidence-Based Training in relation to the MPL

When competence based training has been presented and discussed another thing that has been mentioned at both conferences and in conversations is the "Total Systems Approach" (Harms, 2013). The modules of a professional pilot career could be summarised as selection, initial training & assessment, type rating training & assessment, line training & assessment, recurrent training & assessment and upgrade training & assessment. Harms (2013) stated that the Total Systems Approach referred to the application of the described core competencies and their related behavioural indicators as measurement criteria for all types of training and assessment during the entire professional career of a pilot that also includes instructor selection and qualification.

Competency based training, when used in an MPL course, is directed at candidates aiming for an airline pilot profession without fulfilling the requirement of previous flight experience. However, competency based training can also be applied by airlines during their type-rating and recurrent training and assessment while being better adapted to their current generation of aircraft and events related to those aircraft. This is in essence what in this context is called Evidence-Based Training (EBT). Gary Morrison (2013) described it as *"Training and assessment that is characterised by developing and assessing the overall capability of a trainee across a range of core competencies rather than by measuring the performance of individual events or manoeuvres."* In July 2013 IATA, together with ICAO and IFALPA, published the first edition of an implementation guide for EBT. IATA states that this form of training arose as a safety improvement initiative from an industry-wide consensus that, in order to reduce the airline accident rate, a strategic review of recurrent and type-rating training for airline pilots was necessary - based on evidence (IATA, 2013). The background problems were described by Jacques Drappier at APATS (Asia Pacific Airline Training Symposium) in 2011, stating that flight crew training and checking has been based on events which often are seen as highly improbable in a modern aircraft. In addition, the training programs were considered to be *"consequently saturated with items that not necessarily mitigated the real risks or enhanced safety in modern air transport operations"* (Drappier, 2011). These statements were heard again and reinforced in 2012 by an EBT project member, Patrick Murray, at an ANZSASI (Australian & New Zealand Societies of Air Safety Investigators) conference. Murray also added that *"Automation control, flight path guidance and monitoring is not currently adequately considered in regulations"* (Murray, 2012). IATA confirms and expands those statements in their implementation material. "*The international Standards and national regulations for airline pilot training are largely based on the evidence of accidents involving jet aircraft of the early generations, apparently in the belief that simply repeating pilot exposure to "worst case" events in training was considered sufficient. Over time, novel events occurred that were simply added to the requirements resulting in progressively crowded training programs. This created an inventory or "tick box" approach to training"* (IATA, 2013)

At an IATA conference in London 2013 the senior director of Flight Training Policy at Airbus, Michael Varney, provided an example and perspective on these statements. Varney

(2013) first showed a picture of the cockpit in a DC-3, an aircraft produced between 1936 and 1945. Seconds later the cockpit of a modern Airbus A350 appeared representing a fourth generation jet and at the same time he asked *"does one size fits all?"* Varney then continued by stating that if he was a DC-3 pilot observing a recurrent check session of A350 pilots in a A350 simulator he would be in quite familiar territory, as they would be required to perform the same mandatory manoeuvres and items as on the check for the DC-3. Based on the many improvements that have been made in aviation, e.g. aircraft design, engine reliability and ATC structures, it would be logical to question if the training not should have been adjusted to this. A perspective that gave weight to Varney's statements was that of accident statistics, showing that it took around fourteen years of operation after the implementation of fourth generation jets before any impact on safety was displayed. *"Was there something wrong with the design? – Of course not, as it would not now be showing a definite improvement compared to generation three. Did we put or worst pilots into these new airplanes? – Of course we did not. But did we continue to train how to operate the airplanes in the same way as we have trained for previous generations? – Yes, we did. Because we had to work in the known world."* (Varney, 2013) Varney argued that evidence in this context had a double purpose. The first was to use evidence to demonstrate to regulators that the way aviation training was regulated needed to change. The second meaning suggested that each generation of aircraft faced different critical events and that those relevant to each generation were the ones that should be trained. *"Failures in a modern airplane are much less likely as we have very, very reliable technology. But when we put human beings into the cockpit of what is a complex airplane with an essential simple cockpit design there are always infinite possibilities if something unexpected happens. As we design out the known problems in the system it is the unknown and unforeseen that becomes the main component of our event rate and that we should be trained to handle"* (Varney, 2013). So, the purpose and aim of EBT is to develop resilience in flight crews by allowing them to learn from experimenting when becoming exposed to unexpected and unusual situations. This should over time expand the capabilities and competencies of pilots.

Since EBT is not yet an integral part of the MPL, critically reviewing it will not be a main focus in this report. It should be noted, however, that the main and obvious "resistance" to EBT seems to come from regulators. This is probably due to that EBT will increase the demands on regulators and certainly the demand for regulators to develop and to be more broadly trained in regards to training methodologies and assessment. The chief of the flight operations section at ICAO stated as an example that *"A conduct of over sighting as an inspector in a competency based training program versus a prescriptive training program is very much different. As we are moving towards performance based standards we set an objective but how the objective is reached is very much up to the operator. Auditing that is very much different compared to for example "you can only fly 100 hours per month" where it is much easier to state when any rule is broken"* (Fox, 2013). Here may lie more of regulatory inertia than outright resistance as all stakeholders appear to agree that EBT will bring a much needed change. The view of regulatory inertia also came from the president and CEO of the Flight Safety Foundation, William Voss, who stated "*For those of you not familiar with EBT, let me emphasise what a big deal this is. I have been a long and vocal* *critic of training standards around the world. Our training has been trapped in the 1960s and is dangerously out of date. EBT solves that once and for all"* Voss (2012). Voss continued by highlighting the important role of the regulator; *"As I said, a lot of progress has been made very quickly, but now comes the difficult part. It doesn't do any good to develop new training strategies if you are not allowed to let go of the old ones. Regulators across the world have to buy in to the approach and will have to develop new ways to oversee training. Evaluating an operator's training program against a 50-year-old checklist was a pretty simple regulatory task. Evaluating how well an operator builds its program based on operational data will require a regulator that is insightful and sophisticated, and able to devote a lot of time to the task. That may not be a realistic expectation given that many regulators have been decimated by austerity measures or overrun by extraordinary growth."*

The aim of an EBT program is to identify, develop and evaluate the key competencies required by pilots to operate safely, effectively and efficiently in a commercial air transport environment and this should be accomplished by managing the most relevant threats and errors, based on evidence collected in operations and training (IATA, 2013). The evidence is provided by data from both flight operations and training activities, a data set that has improved substantially over the last 20 years. Sources such as flight data monitoring, flight observations (for instance LOSA programs) and air safety reports give a detailed insight into the threats, errors and undesired aircraft states encountered in modern airline flight operations as well as their relationship to unwanted consequences.

What would logically remain is to determine in what way EBT can be used in coordination with an MPL program. The IATA response is that although MPL and EBT is addressed separately in ICAO documentation (MPL – doc 9868, EBT – doc 9995), the risk analysis that is validated by evidence and collected by the EBT project team, could indeed be used to adapt MPL programs to more accurately represent challenges in the operating environment of the associated airline (IATA, 2013). In a personal conversation with Michael Varney he was asked the question if there were any known MPL programmes that has integrated EBT into the MPL syllabi and if so, if there were any noticeable effects. Varney responded that it was too early to tell but also stated that EBT, when becoming more mature and integrated, will change MPL training to an even higher quality with more relevant content. This statement was also reinforced by Dieter Harms at the MPL "proof of concept"-symposium in Montréal. Harms (2013) stated a future development of the MPL was in fact the incorporation of EBT. Since the authors have not come across a training provider that yet has chosen to do so there can be no evaluation of any results followed by such a decision, but it is perhaps something to consider for those providers who are already running MPL programs.

### 7.4 – Flight Simulation Training Devices

With the shift of paradigm represented by MPL and CBT and the associated increased usage of Flight Simulation Training Devices (FSTDs) as a tool in pilot training it is necessary to review how FSTDs have evolved both in terms of technology and fidelity but also, and more importantly in relation to MPL, in regards to regulatory recognition and qualification.

#### 7.4.1 – History and background to flight simulation

Simulation has today become an industry in its own right as its application has become useful in a vast number of different training areas (Page, n.d.). It has saved lives, time and money for the airline industry (Bürki-Cohen, Soja & Longridge, 1998) and is according to Salas, Bowers & Rhodenizer (1998) now *"a way of life in many aviation training environments."* The application of simulation seems to continue to expand and support new possibilities, based on statements made by simulator manufacturers such as *"technology is no longer an issue"* (Dransfield, 2013). *"The origin of simulators and simulations is closely linked to flight training*" (Greenyer, 2008) and actually dates back almost all the way to the first achievements by aviation pioneers, as training at that time involved great risk. There are from these time reports of frequently occurring accidents, often fatal ones, even for experienced aviators (Greenyer, 2008). In fact, the first person to be killed in a powered fixed-wing flight was an US Army lieutenant flying as a passenger during acceptance trials with Orville Wright as commander in 1908. Another pioneer mentioned in the introduction, Louis Blériot, also crashed several times but was repeatedly fortunate enough to survive. With such a background it is easy to understand why the development of alternative methods of training began. The practice of letting students fly and train by themselves was early replaced by using two-seated aircraft, but as even this was risky the need for alternatives remained (Dahlstrom, 2007). One of the first recorded attempts of constructing a device that could simulate flight was made by the French company Antoinette (Greenyer, 2008). Their device, the "Antoinette Learning Barrel" appeared as first advertised in a catalogue dated 1910 and can be seen in the image below.

*Figure 7.4.1 (1) - The 1910 "Antoinette Learning Barrel" (Source: Greenyer, 2008)*

Other early attempts to increase safety in training included modifying aircraft to remain land-borne. One example of this was to limit throttles to half power and another to reduce the wingspan, thereby preventing the airplane from generating the necessary lift for takeoff and allowing ground operation training and aircraft familiarisation (Greenyer, 2008). The first flight simulator patented is today over 80 years old. Developed by Edwin Link and finished in 1929, the Link Trainer took two years to develop in a factory basement and made use of pneumatic mechanisms from pianos and organs retrieved from his father's company the Link Piano and Organ Company of Birmingham, New York (Page, n.d.). Link is also considered to hold the title *"the father or simulation*" (Page, n.d.). Although the Link Trainer were not the first simulator constructed, as flight simulation was attempted already in 1910, it quickly became the most successful and well-known of its type and was advertised as *"an efficient aeronautical training aid and a novel, profitable amusement device"* (Page, n.d.). An image of the Link Trainer can be seen below.

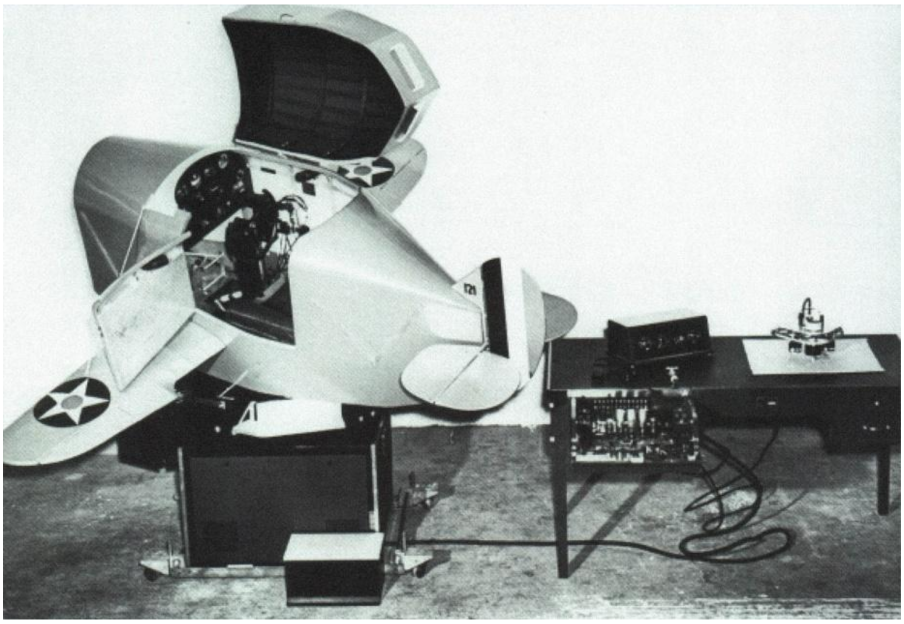

*Figure 7.4.1 (2) - The 1929 Link Trainer (Source: Historic Wings, 2013)*

But despite almost twenty years of inventiveness these synthetic flight trainers were not considered to have kept pace with surrounding advancements made in aviation and was therefore not seen as a substitute for actual flight. The consequence was simply that *"the acceptance of simulated flight had to wait for further developments in the science of flying"* (Page, n.d., p. 3).

Even before World War I started, 70 pilots, of which 41 were military, had died in aviation in Germany alone (Greenyer, 2008). As earlier mentioned, the wars that raged during the first half of the twentieth century, in particular World War II, brought a significant demand for both pilots and effective pilot training in the armed forces. This demand not only created the previously described training legacy, but also caused a rapid acceleration in the development of flight simulation to enhance training safety and efficiency (Page, n.d.). One of the major changes was the advancements made in electronics that enabled a solution to the flight equations of motion. This development allowed a simulation of the response to aerodynamic forces rather than a previous empirical duplication of their effects. Although many of the analogue devices in the early generation contained both forms, some of them were indeed true analogues and argued to be the direct ancestors of the modern flight simulator (Page, n.d.). With the arrival of more modern television technology even visual systems could be integrated into flight simulation, one early example being a camera moving over an artificial landscape and thereby providing visual input (Dahlstrom, 2007). Page (n.d.) states that it was also during the time of war that *"indeed the need for training and the use of simulation had been well established and the benefits proven beyond any doubt.*"

Post-war and into the late 1950s many of the major airlines had purchased their own devices for training purposes. The lack of accurate performance data for both engines and airframes, however, forced manufacturers to apply purposive methods to achieve the desired performance, which was a limitation up to this time (Page, n.d.). This limitation decreased with the arrival of sub-sonic jet transport aircraft. As aircraft manufacturers started performing more extensive flight-testing during development they also started to produce more complete data. This progress, together with that of motion and visual systems, brought pressure from airline operators to improve simulation accuracy, which they hoped would result in a higher quality and efficiency in training (Page, n.d.).

### 7.4.2 – Transfer of training and the need of fidelity

The 1960s could be considered as the starting point for the modern flight simulators, with the introduction of the digital age. Since then new technological solutions have appeared in a rapid pace. The arrival of modern computer power further increased the rate of development of both visual systems and simulator technology in general. This seems particularly true with the use of computer graphics, which brought opportunity to construct even more advanced visual environments (Lee, 2005).

One of the debates still being active today is that of the role of fidelity. This debate has resurfaced to relevance with the MPL, since a large amount of training hours will be spent by cadets in different types of simulators. It regards how to measure training effectiveness and how important fidelity really is in the flight simulator experience in order to achieve the learning outcome intended with the training. Lee (2005) argues that the development of flight simulators has been driven by a perceived need for greater physical fidelity. One such driver has been the community of professional pilots, to which this increase in face fidelity has been important in order to gain acceptance of the training methodology (Roscoe, 1991). It is also true that the companies that manufacture simulators today still work hard with trying to respond to increasing demands from the airline industry on replacing aircraft with simulators and increase both safety and effective operations (Dransfield, 2013).

A term that often comes up in the simulation debates is an element called transfer of training (TOT), i.e. how effectively will training in a simulator become applicable in real life. In any training, the optimal outcome to strive for is that of enabling the cadet to apply any knowledge and skills acquired through training to the situations in a real aircraft. The degree, to which this potential of transfer of training knowledge into real-world applications is achieved, is referred to as transfer of training (Scheck, 2006).

TOT proposes that skills and knowledge required in one environment can be transferred into an environment of similar appearance and setting, in which previously present skills and knowledge can either hinder or facilitate an operator in developing and acquiring new skills and knowledge (Scheck 2006 and Mikhailov, 2011). If the training methodology facilitates a transfer into future situations, both new training- and/or real-life situations, it is considered to be a positive transfer and if it is the opposite it is a negative transfer. There could also be a neutral transfer if past training or experience neither enhances nor hinders acquiring a new skill or reaching the solution of a new problem.

The term “training effectiveness” is a term that refers to the degree to which the training objectives are being met by the contents and methods of the training program curriculum. However, training effectiveness should not be mistaken for “training efficiency”, which instead refers to financial related aspects, such as costs, time requirements and chance of failure, of the training program.

In the context of pilot training, the “real world” training can either be performed in the actual real world, or in an environment which exactly duplicates the real world. Although one of these settings is artificial, both of them place the cadet in a real-life training environment. According to Scheck (2006), there are, however, reasons to why such a real life environment for training is not always possible, or even desirable. Limits in technology are one reason, but Scheck (2006) also states that experience has shown that training effectiveness and efficiency are often enhanced by deviating from the real-life environment. High performance tasks may be more easily learned when broken down into several, smaller and less complex, part-tasks. From another perspective, deviating from the real-life environment carries the risk of not achieving the desired transfer of training by not adequately or sufficiently accomplishing the knowledge and skills required for real life application.

This creates an obvious challenge in how to determine how much of the training environment that can be allowed to deviate from the real-life environment, while maintaining the desired transfer of training. The question is also how much the training environment should deviate to instead improve the transfer of training. Another challenge is how to assess or measure the TOT, which in a way is directly related to the evaluation perspective in CBT when assessing if competency in fact have been achieved. This brings an additional challenge regarding the goal of mutual recognised training standards, as it is difficult for those responsible for training to measure the transfer achieved by one training program versus the transfer achieved by another. According to Scheck (2006), both of these challenges continue to be heavily debated among scholars and practitioners within the aviation training industry. These challenges provide some of the main issues still surrounding the MPL and so far there is not a single or simple answer to them.

There have been different attempts to measure TOT. One basic method is "percent transfer" (PT), where simply the amount of time for specific training, before and after a change has been made to procedures or equipment in that training, is analysed and measured in a percentage which equals saved time (Scheck, 2006). There are different varieties to mathematical formulas used to express this. However, none of them consider the amount of practice performed on the prior task and as such they all have a common fault. As expressed by Roscoe and Williges (1980) this fault permits no conclusions to be made about training efficiency which reasonably is of interest to any training provider who have to be concerned with the "transfer economy" of a training device or technique.

Roscoe and Williges (1980, p.183) also stated that if time has any value, a meaningful basis for measurement of transfer effectiveness in terms of cost is equally essential. A more refined method of measurement that does account for the time of prior practice required to achieve an improvement in transfer is the interaction between the earlier mentioned positive or negative transfer, referred to as transfer effectiveness ratio (TER) (Macchiarella, Arban & Doherty, 2006). The formula for TER is:

**TER = (Tt0 – Tt1) / Ta**

(TER = Transfer Effectiveness Ratio, $T_{t0}$ = Total time before alternate training,
$T_{t1}$ = Total time after alternate training, $T_a$ = Alternate training time)

From this, TER can be calculated and the higher the TER, the more total time is saved making the alternate training time more effective. A negative TER is possible and would imply that the alternate training resulted in more total training time than before the alternative was introduced. According to Scheck (2006), these negative TERs are typically the result of inadequate or faulty simulation, e.g. if a cadet learns to fly on a FSTD which does not correctly simulate the flight characteristics of the actual aircraft, the cadet may have to "unlearn" some of the handling skills acquired during the simulator training. This "unlearning" may take up more training-time in the actual aircraft than it would have taken if the cadet had learned the skills directly in the aircraft in the first place. The net-result of this would be a negative TER.

*"The measurement of transfer is a complex business"* (Roscoe and Williges, 1980, p. 192). In fact, TOT becomes increasingly complex from other perspectives than just methods of measurement. One example of this is the problem of transfer among elements. More specifically, *"simulator training in one flight manoeuvre transfers not only to its airborne counterpart; it transfers to other similar manoeuvres performed either in the simulator or in the airplane, as does training in the airplane itself"* (Roscoe and Williges, 1980, p.192) Also argued by Roscoe and Williges (1980), training on a single aspect of the overall flight task, for example communication, may appear to transfer to a completely different aspect, such as

motor coordination – simply because an early mastery of the first may thereafter allow the cadet to concentrate harder on the second. As training strategies differ the results will be different, for instance if the cadet is required to master a subtask of the flight curriculum before proceeding to the next or master the entire flight curriculum before proceeding to the real aircraft. According to Roscoe and Williges (1980) this concerns both cumulative transfer effectiveness and the relative transfer effectiveness for individual manoeuvres and aspects of performance. This is also why the same training device may show different transfer effectiveness for different phases of a multiphase curriculum, as in the case of the MPL.

There have been a few studies on TOT for aircraft simulation and the results indicate a generally positive transfer of training (Mikhailov, 2011). In fact, training done in simulators that has been combined with training in real aircraft has been shown as more effective than training in real aircraft alone (Hays et al., 1992). More recent studies also show that this effect seems to have a two-way relevance as the level of pilot expertise has shown a connection to the performance in FSTDs as well (Taylor et al., 2007). In addition, Mikhailov (2011) argues that simulators offer several advantages to both the training provider and the cadet. The first one being safety, as the cadet will be able to train without any risk of endangering lives or equipment. Also, the costs of dedicating a passenger aircraft intended to carry fare-paying customers to training would be higher than the cost of using even the most advanced full motion simulator. A similar example was provided by Scheck (2006) who stated that a simple FSTD may cost only tens of dollars an hour versus a high-fidelity full flight simulator, which easily can cost several thousand dollars an hour. Under these circumstances, use of the simple device could still be financially worthwhile even if the resulting TER would be as low as 0.01. ICAO (2010) adds that simulation provides a benefit in that green house gases and noise pollution from flying can be decreased, and so can airspace congestion. Therefore, to consider transfer effectiveness as a simple function of time is an oversimplification as many aspects matter.

When evaluating training effectiveness and efficiency, training quality, economics and TER need to be accompanied by the retention of the training, i.e. for how long the cadet will maintain the KSAs and competencies acquired through training. Swezey & Andrews (in Scheck, 2006) state three variables influence retention; the degree of original learning, characteristics of the learning task and instructional methods and strategies used during training. Of those they claim that the most important is the extent of original learning based on a finding that the greater the degree of previous learning, the slower the rate of forgetting. This has led to some researchers suggesting that any variable leading to high initial levels of learning will facilitate skill retention (Scheck, 2006).

To summarise, the overall effectiveness and efficiency of simulation should influence which training alternatives that should be used. Roscoe and Williges (1980) argue that in the process of training development, the time spent in simulators must be justified in terms of savings in flight time in corresponding aircraft and time spent in small and simple aircraft must be justified in terms of relative savings in large and complex aircraft.

It could be considered almost ironic to broadly question the use of flight simulators as the advancement of simulation was claimed to be one of the reasons behind the MPL, with emphasis on that traditional training methods could not incorporate their full potential (IATA, 2011). But even as apparent positive aspects on training as well as on safety, economy and environment could validate the use of simulators for flight training, one of the questions that remain unanswered is what level of fidelity is required to achieve the best possible training outcome. As the visual component of modern virtual environments is being provided by a dozen satellite images in advanced simulators, today's focus in development has turned to more enhanced environmental simulation of air traffic control and more detailed traffic and weather experiences (Siew, 2005). Dahlstrom (2007) argues that this constant demand for more and higher levels of high-fidelity simulation could trap aviation training in a spiral of increased cost and lower availability of simulators. Indications are that the huge capital investment required tends to concentrate available high-fidelity simulators to a limited number of locations across the world. What becomes interesting is that despite the face validity and visual persuasiveness of high-fidelity flight simulation, it is actually uncertain whether these features improve the quality of training and results in a better transfer of training to real situations (Salas et al., 1998 and Roscoe, 1991). A perspective on this was provided by Marsha Bell, Vice President, First Officer Programs, Alteon Training (Daly, 2006) who said: *"I have been around simulators for about 20 years and there are plenty of times that pilots emerge soaked in sweat from the simulator with a renewed appreciation of what can go wrong."* As noted by Dahlstrom (2007), this seemingly convincing statement, however, does not provide any conclusions about the relevance or transfer of the training performed in the simulator to a real situation, but only that the simulator can create overload situations similar to those encountered and experienced during flight with a real aircraft. Reasonably more important, it says even less regarding the relevance, transfer and usefulness of simulation in basic civil aviation training in general. As mentioned, recent studies show a correlation of performance to the level of experience of the pilot, as an experienced pilot has a greater chance of being able to recreate and integrate context from previously experienced situations and thus increase the fidelity of the simulated scenarios (Taylor et al., 2007; Dahlstrom, 2007). As there are no requirements of previous flight experience for an MPL cadet most of them will have little or no such experience when their training is initiated. The impact of simulation could therefore be considered far less predictable for a novice and needs to be considered with at least an equal level of attention to the effects of expectations and context on the learning experience as for the experienced pilot.

Higher fidelity does equal higher costs. From the financial perspectives this becomes an issue as the acceptance of lower levels of fidelity for training credit has been slow (Koonce & Bramble, 1998). There have been attempts to design systems using commercially available components at a very low cost and at the same time achieve acceptable levels of performance for simulation. The conclusion of one such study, using qualified pilots to provide important feedback from the probable end user, states that the ratings collected shows a promising approach for the cost conscientious user (Bouthillier, Liang & Allard, n.d.). The pilots suggested that such low level fidelity device could potentially be used to train new pilots to accomplish manoeuvres. Others argued it to be an excellent inexpensive IFR-trainer as the motion experienced would contribute to instrument flight scenarios where visibility is inexistent and the pilot would be forced to rely on his instrument instead of any motion cues. But as the industry continues to demand higher fidelity it becomes difficult to speculate when these lower level devices will receive acceptance and approval.

Jackson (1993) emphasised that simulation fidelity and capability should be sufficient to ensure the required transfer of training, but that exceeding this would increase system cost with no return. Such a validation would also be a critical ingredient in the development of valuable and relevant scenarios that could help teach cognitive and collaborative skills, independent of the level of simulation fidelity (Dahlstrom, 2007). It could logically be argued that what is important is not how much the simulation actually resembles "the real thing", but to what extent it is able to appeal to, and develop the skills that will be needed in actual practice. In fact, there are indications of that the transfer of cognitive and procedural training to practice may in fact benefit from lower-fidelity simulations when it comes to the management of complex and demanding situations as it removes distracting "featurism" from the training environment (Jackson, 1993). This statement was later also confirmed by Caird (1996) who claimed there to be some evidence from flight simulation that higher levels of fidelity have little or no effect on skill transfer and reductions in fidelity actually improve training. Reductions of complexity may aid working memory and attention as skills and knowledge is initially acquired. As Dahlstrom (2007) puts it, it is questionable how different levels of fidelity in training can be connected to different levels of learning.

The results of additional studies confirm that high fidelity alone is not the key to successful learning. Dennis and Harris (1998) compared a desktop simulation using keyboard controls with a high-fidelity simulator using controls very much similar to the ones used in a cockpit. Their study showed that in both case of simulation the results revealed a positive transfer to performance in actual flight, but most importantly, the level of fidelity had no significant impact on this transfer. Their finding resulted in a suggestion of that the value of simulation was not in promoting psychomotor skill development, but instead in helping the students to construct a cognitive template of what actual flight really will be like. Two similar studies also performing a comparison between desktop simulations and high-fidelity simulators reached similar conclusive statements. Philips, Hulin and Lamermayes (1993) even found that the students trained on the desktop simulator had a better pass/fail rate than those trained in the high-fidelity simulator. Ortiz, Kopp and Willenbucher (1995) did not find any differences in regard to performance, but noted, perhaps not surprisingly, large cost savings when using the desktop setting instead of the high-fidelity environment.

Caird (1996, p. 127) argued *"For decades, the naive but persistent theory of fidelity has guided the fit of simulation systems to training"* and Roscoe (1991, p.1) stated that *"research has shown that innovations in training strategies, in some cases involving intentional departures from reality, can have stronger effects than high simulator fidelity on the resulting quality of pilot performance."* If there is an answer to the question of relevance in level of fidelity perhaps it lies within a perspective provided by Dahlstrom (2007); *"If there really is a link between simulator level-of-fidelity and training return-on-investment, then this* *connection is probably much more complex than the aviation and simulator industry may think, depending critically on quality and relevance of the scenario and the exportability of the skills acquired during the simulation.*" But there might be an alternative solution contained in the ongoing development of regulatory mutual recognition in FSTDs.

### 7.4.3 – Regulatory recognition and qualification of flight simulators

As the MPL training will enable the use of simulators in each training phase it also becomes relevant to study what requirements have been placed on the simulators. As the devices continuously develop regulators have quickly become forced to consider easily available computer software for flight simulation as a recognised training tool (Dennis & Harris, 1998).

*"The commercial flight simulation market has been shaped by the tension between the thrust of technology and the drag of regulation"* (Warwick, 2008). Technology has enabled synthetic training but regulation has restricted its full potential as qualification standards have failed to keep pace with the advancements made in simulation. In 1992 there were early efforts made to harmonise the FSTD standards to an international level and in 1995 the ICAO doc 9625 was published as a result of that effort, describing the minimum requirements for qualification of flight simulators (Clément, 2009). This manual was later updated in 2001-2002 as a response to changes in simulation technology, but it only defined the highest level of flight simulators.

When the MPL became an approved certificate there had been no additional updates made causing a distinct lack of harmonisation of standards for especially the previously unattended lower-level devices (Warwick, 2008). As the use of simulation increases there are now more simulator manufactures than ever (Dransfield, 2013) and simulators range from everything between a basic computer and joystick interface to the full motion cockpit replica operating on a platform with six degrees of freedom. But the FAA, EASA and ICAO all qualify FSTD differently resulting in 27 different type qualifications (Clément, 2009). Mikhailov (2011) argues that this lack of standardization could lead to confusion as well as in the end questioning of the very concept of the MPL.

In November 2005, at the request of the FAA, the UK Aeronautical Society (RAeS) agreed to establish an international working group (IWG) in order to review the ICAO technical standards and expand them to this time include all of the devices, including also helicopters. The FAA proposal was to harmonise all simulator levels and align them with their purpose, a work that began in March 2006 (Warwick, 2008). The manager of training solutions, verification and validation at CAE, Stephane Clément, also co-chairman of this international working group stated that there were many reasons behind this initiative, including the need to accommodate new technology and the emergence of the MPL. In addition, the chairman of the international committee for FSTD qualification (ICFQ) at the RAeS, Peter Tharp, also stated in 2013 that the objective was to allow harmonisation of standards, to provide common clear vocabulary and definitions, and to enable the national aviation authorities to have a uniform interpretation of flight simulation criteria. The aim was to lead on to more mutual recognition and increased overall efficiency.

The working group formed two subgroups, training and technical. The training group started by listing all of the training tasks that pilots have to do, including every license type, type rating and recurrent training. For example, in order to perform a take-off seven major task were listed ranging between pre-take-off preparation to managing abnormal and emergency situations. The work found approximately 200 training tasks for each of the 15 license and rating types (ICAO, 2009). The group then decided what level of fidelity, divided into none (N) (if not required), generic (G), representative (R) or specific (S) to the aircraft that each task required for each of 13 features identified in the simulator. The features included for instance cockpit, flight model, systems, flight controls, and visual and motion environment - such as weather and air traffic control. Clément (2009) stated that they had to decide whether the task was to train (T) or demonstrate proficiency (TP) and from there on determine the necessary level of fidelity. The technical subgroup then took this analysis and searched for natural grouping of fidelity levels. An example of this in the regard to the MPL can be seen in APPENDIX 7 and an example of a comparison in task training FSTD requirements between MPL phase 1 and phase 4 can be seen in APPENDIX 8-9. The ICAO minimum level of requirements that exist today can be seen in the MPL training scheme at p.25.

The group's four-year effort resulted in a change from 27 different type qualifications into seven different levels ranging from a simple, level 1, desktop trainer to a high-fidelity, level 7, full flight simulator. Their work was published in ICAO manual doc 9625 edition three in July 2009, and appeared to be welcomed by the aviation industry. The group president of simulation products at CAE, Marc Parent, stated that *"this is the first really complete review to align equipment specifications with training tasks"* and that the new standards will benefit operators *"because they are based on a training task analysis that provides much more clarity when designing a training programme"* (Warwick, 2008).

But as this manual is not a mandatory standard that each ICAO state is obliged to adopt, the interesting question is what has happened since in terms of regulatory recognition. Tharp (2013) stated that the reason for spending so much time on this work was that this new ICAO document intended to provide the means for authorities or other states to accept the qualification granted by the state which conducted the initial and recurrent evaluation– *"the holy grail of mutual recognition",* making more efficient use of global resources. As each authority need to approve and qualify simulators used for training within their respective regulatory responsibility, a study made by IATA estimates that around $32 million can be saved annually just on recurrent evaluations if the mutual recognition becomes reality (Tharp, 2013). The purpose of the ICFQ, established shortly after the IWG had finished their work, is to address training and technology issues as they come up, keeping the standards up-to-date. The biggest challenge right now appears as a slow adoption pace from regulators across the world. As of today there seem to be only one country that has adopted regulation based on the content of doc 9625 and in May 2013 the first simulator qualification with the new regulation was performed in Singapore followed by some additional later that year (Ponoroff, 2013).

Tharp (2013) stated that both Russia and Indonesia also reported that they had adopted the document but that it seemed a bit confusing as recent simulator qualification had been made with the old regulation. Next in turn would be the Australian CASA in 2013-2014. EASA, FAA and TC reports that they plan to adopt the new regulation but that it is likely not completed before 2016. The entire Asia-Pacific region appears to wait and see what EASA and FAA does and reports no intentions or timeframe (Tharp, 2013). If the IATA study is accurate, this delay in adoption would suggest that operators would have spent more than $220 million on FSTD recurrent evaluations by the time the major regulators have adopted the ICAO document. Millions that could have been saved or invested in different areas if there were less regulatory inertia and this is where the industry stands in the beginning of 2014, still qualifying simulators based on technical specifications without mutual recognition.

The ICAO course tracker of the different MPL programs reveals more differences than similarities between hardware being used, in terms of both aircraft and simulators, in MPL training (see APPENDIX 3), especially in phase 2 and 3. Mikhailov (2011) argues that as a large part of the MPL training is performed in simulators, the non standardised approach to simulation is being reflected in the many differences between the existing MPL programmes. However, this does not necessarily have to be a bad thing.

The vice president of validation & qualification at Mechtronix Inc., Mark Dransfield, provided an alternative approach to FSTD qualification for these lower-level devices both at the IATA ITQI conference in June 2013 and at the MPL symposium in December that same year. With a perhaps to some provocative title, “The beginning of the end for FSTD qualification levels”, Dransfield (2013) read from the conference program and asked a rhetorical question; *“If the goal is to shift the emphasis of pilot training, from a task-based to a competency-based training approach, through the examination of evidence, with the goal to mitigate the risks and threats faced in everyday operations – shouldn’t we also evaluate simulators to be suitable for exactly that reason?* Dransfield’s theory was that as the competency-based framework brings a new more flexible approach and methodology to training, evaluation could be made more flexible for FSTDs as well. As regulators have not yet adopted the content of ICAO doc 9625, Dransfield (2013) argues that as simulation technology has continued to evolve it has now produced a dilemma; today’s FSTDs still do not match the existing regulatory FSTD qualification criteria and associated training and testing credits. Instead, as regulations remain based on technical specifications, the simulators today actually far exceed the regulatory technical specified requirements and would be far more capable to deliver more training outcomes then what they end up being qualified for (Dransfield, 2013). It is based on this reality that Dransfield suggested an alternative evaluation approach – to instead assess the capability of the device to deliver a requested training outcome as a base of qualification. *“We know the training types we need to deliver down to an individual task level. We know based on the work done with ICAO doc 9625, that we can describe any simulator by looking at all of the specific features built into the device and say “how much of this do I need to do this or that? How much visual or motion do I need?”* (Dransfield, 2013) – suggesting that there already is an answer as the analysis has been done by the IWG. In competence-based training, the simulators should only be seen as a tool to be used in the overall process of training cadets to a defined level of competence. Thereby they should not be assessed based on technical specifications or type of device, but based on the competencies possible to achieve. It would be logical to ask why the seven identified levels in ICAO doc 9625 cannot be used as they are for this purpose. Dransfield's (2013) response is that they are not really qualification levels but more examples of combinations from the training matrix created by the IWG that states what features and to what extent they are necessary to achieve a training task. The suggestion was to assess and evaluate simulators in the same way, removing older terminology based on predefined technical specification and descriptions such as FTD, FNPT MCC, FSTD Level V, and move towards evaluation and approval based on training task based standard. Dransfield (2013) stated that this should be done with the most advanced FSTDs as well, the full flight simulators. Perhaps, this discussion can provide a foundation to continue the debate on fidelity requirements in simulators as they now have been, in one way, straightened out in relation to the intended training tasks.

# 8. DISCUSSION – THE MPL REALITY AND EXPERIENCES

It would be ambitious to here propose the content of an MPL industry best practice training programme even when based on the previous literature review and supported by stakeholder interviews and material from conference proceedings. Even if the content would be based on the experiences gathered from MPL training providers worldwide there are several unknown factors behind their results that make them difficult to validate. Instead, the experiences have provided a solid foundation to base a discussion upon, which perhaps in turn can provide the industry with important aspects that allows for improved future development of the MPL.

Due to the nature of this report, it was deemed productive to combine the lessons learned and other results with discussions and then propose recommendations. This discussion section is based on the central subtopics identified in the study. It includes cross referencing to literature and stakeholder statements as per previous sections.

## 8.1 – The challenges of future pilot demand

The MPL was early on seen as a response to a predicted growing demand for pilots. The debate about pilot supply seems to go hand in hand with the one of variability in pilot training quality and standards. During the past fifteen years statements from ICAO, IATA and OEMs have mentioned pilot shortage as a looming problem and as a response many stakeholders have tried to analyse this potential problem (Bent, 2013).

The aircraft manufacturers provide their own market outlook to plan for the future. According to Boeing (2013), the airlines will need to hire 498 000 pilots by the end of 2031 to man their projection of around 34 000 new aircraft and to replace pilots leaving the industry. Airbus market outlook states that almost 30 000 new aircraft is required by the end of 2032, of which 38% will replace old aircraft and 62% are new ones (Airbus, 2013). In fact, if divided into regions these predictions state that the current global aircraft fleet will triple in Asia and double everywhere else in the world within the next twenty years. At the ASEAN Aviation Training & Education Summit held in Jakarta in January 2013 the secretary general at ICAO, Raymond Benjamin, said, "*30% of the total aviation workforce will retire in the period 2013-2014. For all key participants more effective training competencies must be defined*" (Bent, 2013). The market seem to agree on that the estimated need is somewhere around 23000-25000 new pilots each year to meet new demands, support growth and replace those retiring (Bent, 2013). But even as projection methodology continues to improve there will be unforeseeable events, such as geopolitical or economic, that cannot be predicted and catered for. At an IATA ITQI conference in 2013 the chairman of the International Pilot Training Consortium, John Bent, provided a historical perspective on why decision makers have a hard time to agree on these projections.

In 1997 there were major pilot shortages predicted, with no apparent solution in the near future. What happened next was a combination of economic decline and the 9/11 event, sending a shockwave through the aviation industry and the shortage was gone in seconds –

*"see, no shortage now"*, as Bent (2013) put it. A couple of years later in 2003-2004, SARS happened along with a global fuel crisis, which again in a way solved the still smaller, but predicted, pilot shortage situation. Almost at the same time ICAO raised the retirement age for a pilot from 60 to 65 allowing each pilot to work longer and thus the need for new pilots decreased, at least temporarily and again the shortage was gone. Next came 2007 and several US regional airlines started to run out of pilots to hire. The situation was serious for some time but the issue was again solved in 2008, when the global financial crisis caused a large recession. As always this brought challenges in growth and survival for airlines and a need to terminate existing employees rather than bringing in new ones. "No hiring equals no shortage", (Bent, 2013). 2011 brought heavy orders for new aircraft to aircraft manufacturers along with the beginning of a substantial growth of commercial aviation operations in the Asia-Pacific region. This and the first surge in 2012 of age 65 retirements again created a projection of a rapidly increasing demand for new pilots. In 2013 recession in Europe was still around and yet once again the aviation industry has self-corrected its needs. Bent (2013) stated that these historic events in a way have created and supported a mind-set of comfortable belief that self-correction will continue even though new demand projections claims the opposite. Some describe it as *"projection fatigue"* causing decision makers to ask *"why won't the market self-correct again?"* (Bent, 2013). Bent (2013), however, argues that in the second half of 2013 the situation is different from before as the different projections and analyses are converging and has become more accepted. This situation has created a consensus of that the threat of pilot shortages this time is real.

A slightly different perspective on the challenges with pilot demands in term of supply becomes revealed if the aviation industry is divided into different regions. The United States alone today represent around 34% of the global aviation industry and contributes more than any other region to the global supply with several well-established training providers (Bent, 2013). In 2012 FAA's head of flight standards, John Allen, stated that the projected retirement numbers are *"astounding and dramatic"* and *"we don't have a system to address this issue"* (Carey et al. 2012). In November that same year the Wall Street Journal wrote *"U.S. airlines are facing what threatens to be their most serious pilot shortage since the 1960's with higher experience requirements in Aug 2013 just as the industry braces for a wave of retirements"* (Carey et al. 2012). How this situation will affect the rest of the world, especially Asia as today's "new-pilot" top consumer, might be too early to tell, but current spare training capacity in the U.S. could become completely absorbed by the growing demand in the US alone (Bent, 2013). As a result of the many different statements and predictions a stakeholder group sponsored by AABI (Aviation Accreditation Board International) and the UAA (University Aviation Association) was formed to analyse the current state of airline pilot labour supply in the U.S. The study was published on 13 March 2013 and an extract of the summary confirms that U.S. demand challenges, if they materialise, will present the global industry with a very real pilot supply problem (Higgins et al. 2013);

*"...given that it takes several years for a pilot to enter the airline pilot labour supply, the industry cannot afford to wait and see."*
*"...the industry must make its best efforts to forecast and mitigate, if necessary, any future shortages, and the efforts should begin now and in earnest."*
*"The likely result of inadequate staffing will be the reduction of flying in smaller-communities and other markets served by regional airlines."*
*"The overall effect could also cause harm and disruption to the entire airline industry and given its effect on the national economy, this threat should be taken seriously, and mitigations should be enacted in an attempt to circumvent this potential hardship"*

If the focus is moved to analysing Asia, one state alone - China, provides another perspective on the challenge ahead. According to the CAAC, (Civil Aviation Administration of China) that regulates 33 airlines in China, there is a demand for over 18 000 new pilots by the end of 2015. There is an alarming shortfall in the annual number of domestic pilot graduates, requiring a large number to be overseas trained plus already qualified pilots paid to work in China (Bent, 2013). Another example from Asia is Lion Air in Indonesia. Lion Air had 92 aircraft in their fleet last year and has ordered 230 new Boeing aircraft and 234 new Airbus aircraft. In order to man this quintupling of the fleet this company alone require 3 500 new pilots (Bent, 2013). These numbers can also be found in the market outlook of aircraft manufacturers. Boeing predicts an average annual growth of 5%, as it has been more or less since 1980, but for Asia that number will be around 6.2% (Boeing, 2013). In 2013 one of the highest growth rates in Asia came from the airline Asiana, with a 9% increase in revenue passenger kilometres (RPKs) (Bent, 2013). The Chief Operating Officer – Customers at Airbus, John Leahy, stated in 2013 that the airline industry today has grown by 70% in terms of RPKs in the last ten years and according to their projections it will increase by an additional 151% up to 2032 from 2012. *"Every fifteen years, the industry doubles in size"* (Leahy, 2013). Leahy (2013) also stated that just five or six years ago, the top three markets were North America, Europe and Asia-Pacific in that specific order. Today, the order is reversed with Asia-Pacific holding 29% of the market, followed by Europe and North America at 26% and 25% respectively. During the next twenty years the order of market size will remain as today but will instead be 34%, 22% and 18% if the projections at Airbus come true. Leahy (2013) also points out the runner up will be domestic China, followed by domestic India, with between 7-10% of annual growth rate alone. These regions will be followed by the Middle East at 12% of the global market in 2032 where growing trends can in some ways already be confirmed as Emirates airline ordered 200 new aircraft at the Dubai Air Show in November 2013, valued around $100 billion at list prices (Airbus, 2013 and Emirates, 2013). As training resources in the U.S, and Europe may decrease, training resources and providers will develop in the Asia-Pacific region. However, since the annual need of Asia alone is estimated to around 10 300 new pilots each year the development to full self-sufficiency in regard to training capacity could take up to ten years unless it accelerates (Bent, 2013). This trend could to some extent already be seen as the number of MPL training providers has expanded mainly in Asia-Pacific region during recent years (ICAO, 2013).

The European situation is similar to the one in the U.S. in terms of pilot demand (Boeing, 2013 and Airbus, 2013). Europe will probably still be affected by economic challenges and their related aviation industries need to make the efforts to maintain a sustainable growth. Bent (2013) argues that every region will eventually probably find that “pilot poaching” is a finite source and since not every pilot is prepared to move to another part of the world it ultimately makes pilot mobility a limited resource. Should the projections prove to be right this time, it is likely that development in aviation training over the next few years will have to be responsive to this new situation.

### 8.2 – The next generation of aviation professionals and the selection of MPL cadets

The challenge of supply is only one part of the equation. In order to find a sustainable solution the aviation industry will also need to ensure the quality of pilot selection and the training process. Local excess training capacity may or may not solve demand elsewhere, but if the local demand also requires cross-border training it generates quality and standards challenges when trying to match the standards between different regions and countries (Bent, 2013). Poor harmonisation of global training is of concern and a recent stakeholder survey done by the Royal Aeronautical Society shows that 62% is dissatisfied with the consistency of training standards around the world and as many as 97% saw a benefit to safety in having international standards for flight crew training (Bent, 2013). There are several initiatives already in play in order to address this issue, some being the IPTS, PABC, IAAPS, IPPTG and IAFTP (see glossary of acronyms). IATA’s response was to launch a training and qualification initiative shortly after the MPL introduction in 2007, the IATA ITQI, aiming to strengthen aviation training, secure the need of next generation pilots and support the worldwide implementation process of the MPL (IATA, 2013). The IATA Safety, Operations and Infrastructure senior vice president, Günther Matschnigg (2012), states that the project *“strives to dramatically shift the emphasis of training and improve safety by focusing on a competency-based approach through the examination of evidence with the goal to mitigate the real risks and threats faced in everyday operations.”* From ICAO (2013) came the Next Generation of Aviation Professionals (NGAP) initiative as an attempt *to “ensure that enough qualified and competent aviation professionals are available to operate, manage and maintain the future international air transport system*”. The initiative is supported by many organisations and the situation is considered critical, based on that a large contingent of the current generation of aviation professionals will retire, that access to affordable training and education is increasingly problematic, and that aviation competes with other industry sectors for highly skilled professionals (ICAO, 2013). In addition, ICAO (2013) states that the lack of harmonised competencies in some aviation disciplines, and a lack of awareness of the “next generation” types of aviation jobs available, further compounds the problem.

At the same IATA ITQI-conference, John Bent (2013) put this in perspective with a quote from the Director of the Singapore Aviation Academy, Dr. Michael Lim, who said *“USD 350 billion is spent on aircraft and infrastructure but the investment in people is tiny by comparison.”* Also a consultant in pilot training developments for IATA, John Bent (2013) continued and stated; *"With the challenges ahead it is likely that priorities will need to change, but only limited action is possible unless airline leaders recognise that pilot supply shortages and training quality deficiencies are real and presents real threats to future commercial success."*

When looking at the differences in training experience between experienced pilots approaching retirement age and newly trained pilots entering commercial aviation service today, two things can be compared. The first is how the training to initial proficiency was performed or in what way the initial experience was acquired. Many of the experienced and soon to be retired pilots today are generally ex-military pilots referred to as *"baby-boomers"* (Bent, 2013). A pilot shortage is said to have occurred during the 1960's because *"everyone who was of trainable age was in Vietnam"* according to former FAA administrator Randy Babbit who was hired as a pilot in that era (Carey et al., 2012). Post war-time many of the baby-boomers joined the civil world of aviation after completing their service and had thereby gained their initial experience through the military. The benefits for the airline companies who hired them were perhaps above all their ability to more or less begin working immediately with the only need of a short conversion course and some company training. Today this is a rare situation due to a decreasing military sector and a demand for new pilots within the transport sector that continues to grow (Learmount, 2012). The major source of new pilots today is instead cadets or other individuals performing their training with a training provider or airline, starting from basic levels of experience or no experience at all. Normally no previous flight experience is required, so when training is completed the training flight time also counts for the graduates' total experience so far. With "baby-boomers" retiring and newly trained cadets taking their place, this means that the average experience in terms of flight hours on flight decks will decrease significantly during the next decade (Bent, 2013). IFALPA agrees in their published pilot training standards by stating that *"the gradual erosion of training time will have a delayed effect as the older generation of pilots leave the left seat and take their experience with them"* (IFALPA, 2012, p.3). Focus on quarterly results probably directs attention away from the long lead-times needed for pilot supply. A recurring question that has been asked by the industry, but perhaps is of more interest now, is if there will be growth-related safety challenges on the path towards a sustainable solution. In fact, some of the accidents that occurred already during 2013 have involved considerations about growth pressures and suboptimal training as causal factors (Bent, 2013).

Another potential generational difference has also been discussed. The development in technology and automation over recent decades that has occurred, not only in the aviation industry, may have led to changes in behavioural patterns and individual capabilities (IATA, 2013 and Heath, 2013). Technology has also brought a paradigm shift in the demands of pilot skills. It could be argued that the increasing presence of automation has not only changed the skills required by newer generations of professional pilots, they have also increased the demand for certain skills. This can be illustrated with the image below.

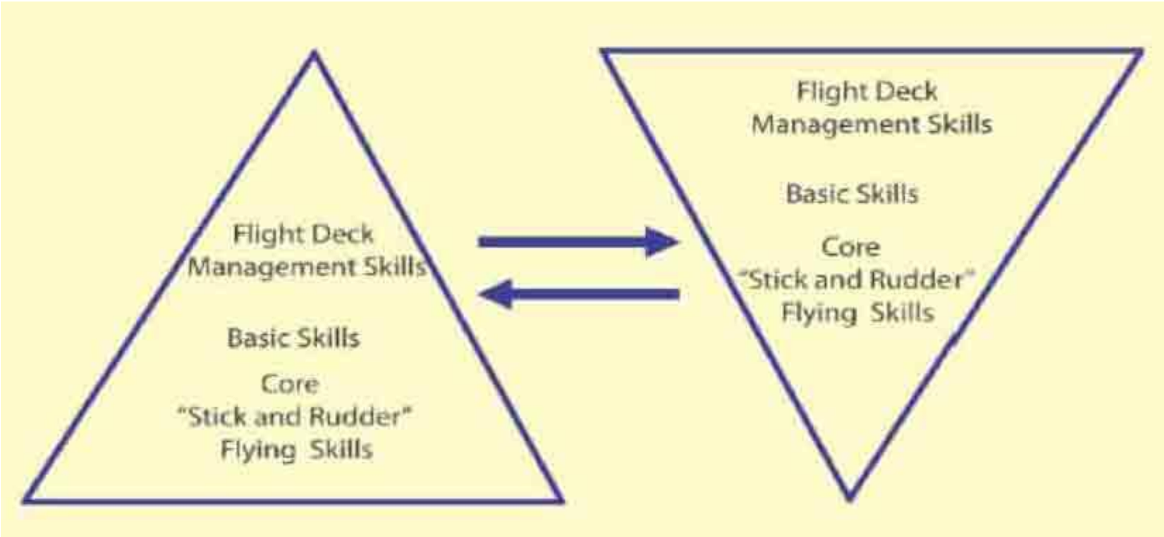


*Fig 8.2 – Different sets of pilot skills (Source: IFALPA, IPTS, 2012)*

The left triangle demonstrates a skill-set that requires more basic or core skills, e.g. flying a hand-flown approach. The right triangle reflects a skill-set that requires more management skills, e.g. flying a coupled RNP approach. Technology and automation have shifted the skill requirements in normal operations to be more characterised by the triangle to the right. However, when and if technology fails the pilots have to be able to also master the skills represented by the left triangle. Although technology has made aircraft safer, human requirements have increased even if some of the required skills rarely need to be used. As stated by IFALPA (2012, p.3), *"the importance of these different skill-sets varies with current circumstances and accordingly, an effective training programme must be aimed at first reconciling these skills and then optimizing the interplay between them."* Considering the competency-based framework, the MPL should have a higher possibility in achieving this compared to the traditional training.

The digital upgrade of the world has made it a smaller place, with user-friendly and efficient methods for communication and transport that also have created multiple new options for young people when it comes to choice of career. Options like these did not exist just a couple of decades ago and have had an impact on the attractiveness of an aviation career (IATA, 2013). When faced with career choices, the digital generation may relegate a piloting career down their priority list (Polek, 2013). In fact, airline piloting careers in many regions are less attractive due to factors of the job such as decreasing pay, shift work and fatigue. A survey done by the aviation department at the University of North Dakota showed that out of 205 aviation students, 32% stated that they now are reconsidering their plans and 8% stated that the already had abandoned aviation as a career path. When asked what was needed to convince them to actually consider the airline career, the three most mentioned aspects were increased salary, a more family-friendly lifestyle and improved work schedules (Polek, 2013). IATA (2013) states that while "passion" and interest still seem to exist amongst young people, this passion may be insufficient to take an active step towards the airline pilot career.

The first challenge with an MPL program is the screening and selection of candidates. The MPL training industry seem to stand united in claiming that selecting the right people for training is crucial for the quality of the outcome (as supported by statements from Lufthansa, Swiss, Ethiopian, Dragonair, CAE etc.). IATA (2012) states that *"professional aptitude testing for airline pilots, if correctly implemented, can contribute considerably to cost savings and enhanced safety for an airline. Selection is the first point of action, where no costs have yet been sunk, and improving this part of the process is critical to the avoidance of future risk and cost."* If sufficiently qualified applicants can be found the aviation industry then has to solve if generational differences presents new selection and training challenges.

As mentioned the now retiring generation is referred to as the "baby-boomers", while the younger one instead has been called the "digital natives". This is a generation that has grown up in a world of computer-based digital applications and with continually and rapidly advancing technology. Several perspectives on changes in learning style, expectations, behaviour and social and cultural transformations can be found in a study and commentary made by Professor Erica McWilliam, who works in the field of pedagogical innovation at the ARC Centre of Excellence for Creative Industries and Innovation at the Queensland University of Technology. McWilliam (2013) argues that today's western work life culture shows little interest in the skill of craftsmanship, the individual talent of doing one thing extremely well, especially in fields of technology, sciences and advanced forms of manufacturing. It would be reasonable to argue that those include aviation. Several senior pilots interviewed argues that *"flying is a craftsmanship"* developed through years and years of practice. True or not, McWilliam's (2013) point of view is that *" in a time when long-term stable employment recedes, and fast-paced work transitions become the norm, we now find ourselves paying closer attention to managing short-term relationships while migrating from place to place, job to job and task to task, re-developing new talents as economic and skilling demands shift."* The digital natives have never learned about the world events by reading a newspaper or by watching the news on television, to them *"the world looks, feels and sounds like YouTube"* (McWilliam, 2013). As McWilliam puts it, to this next generation it is not *"a miracle to search 100 billion pages in 15 seconds."* Instead, likely to be recognised by many, the frustration rises from what is perceived as a delay or slowness of access or delivery.

An aviation perspective confirming this generational difference was provided by an UK expert in human performance, Nikki Heath, at the MPL symposium in Montréal 2013. Heath (2013) argued that new generations born to computers may expect instant answers and may also find gratification delays difficult since most of today's technology operates in high speed delivering quick results - they are *"immediate."* The next generation shows strong capabilities in technical skill and knowledge, deemed logical based on their surrounding environment when growing up. Instead, there are difficulties in analytical areas. Information processing has changed as *"facts are in and gone",* in other words quickly lost or never analysed once found. Other noticed differences is a different learning style, a different core skill set, different expectations and even the way the next generation communicates has changed. Heath (2013) gave an example from the company IBM who apparently selected their candidates based on their activity in social media.

But Heath (2013) also raised a relevant question. It is indeed questionable if the training providers use a selection process and related test battery that *"test for training or test for employment"*, argued by Heath as two completely different things. An example provided came from the armed forces where the best performing cadets in training completely broke down in the real life situations of battle where instead those with mediocre performance in training handled both their colleagues and the situation. Theoretically, the same thing could very well happen in aviation if the screening objective is wrong from the start. The mindset preferably needs to be to *"select in, rather than select out"* and Heath (2013) stated that individual life experience has proven relevant and that it has now started to become possible in a screening process to predict how a person really will react to a stressful situation that had never been previously experienced.

None of the asked MPL training providers wanted to comment on or discuss their screening process based on the integrity and importance of that they were kept away from public knowledge. From a different perspective this could also be questioned. If life experience really does matter and the screening process tests for signs of competence and psychometric capabilities for instance, it would theoretically benefit the airline industry if the future candidates at least know what competencies are considered required, thus allowing them to strengthen them in their everyday life experience before applying. However, the only openly information available is simply the initial requirements to be able to send an application but this alone unfortunately does not provide a solid foundation for knowledge about the process.

Nevertheless, there seem to be areas that allow room for improvement. Matschnigg (2012) stated that *"despite the clear benefits of a proper pilot selection process, the results showed that only a minority of airlines have a specific selection system in place that is structured and scientifically-based."* IATA (2012) states that *"national regulators worldwide have been reluctant to develop guidance on personality, yet this criterion is most important for flight crew."* Harms (2013) argued for a need to synchronise the aptitude testing with the core competencies, again referring to this as a part of the total systems approach. The executive vice president at PremiAir Aerospace, Jon Adams (2013), brought attention to the need of English language proficiency, which has been noted to have been an issue in some MPL programs and argued at the MPL symposium in Montréal that a *"minimum threshold for acceptance into the MPL program must be clearly established."* According to IATA (2012) many training providers argues that training itself is the most realistic assessment and selection platform. The obvious downside would be that costs build up as the cadet progresses into training generating no return on investment if eventually failing. IATA (2012) also argues that this argument is not supported by facts, as selection during the training process generates low values of predictive validity. A potentially more dangerous aspect to selection is those cadets who "slip through". *"Many cadets manage to get a license despite some challenges during training, and as their flying experience increases, they learn to compensate for their weaknesses in normal operations"* (IATA, 2012). Any deficiencies associated with those cadets may resurface when faced with challenging situations and high performance demand, especially in times of stress and fatigue. The screening and selection process is thereby not only associated with long term cost savings, even more crucial, it is an important aspect of aviation safety. On balance though, MPL training programs are equipped with the necessary tools to find those cadets who slip through if they are using a well managed continuous feedback and quality assurance system. In addition, the MPL training providers not also being airlines, such as CAE, CAAC and FlightPath International, emphasise that airline involvement should be high even in the training stages before line training, and especially during the selection phase as criteria might differ (Toering, Morrison and Hongqiu, 2013). In a way it becomes reasonable to say that while the traditional training route hopefully ends with a job interview, the MPL programme actually starts with one.

Thus, with the lack of access to any more in-depth information regarding methodology and aim of screening and selection processes, these can only be analysed based on available commentary and studies. In an attempt to summarise, one thing seems true – screening and selecting the right people is of both vital safety and economic long-term importance. The test battery should reflect the demands faced when exercising the profession and not only the requirements for passing through the training system. It should also include testing for core competencies agreed in the industry and for solid English language proficiency, perhaps even evaluating life experience in the process. Throughout this process, the host airline should be closely involved.

According to UN statistics people under the age 25 make up for around 43% of the world's population and developing nations account for 60% of them (UN data, 2013). The characteristics of the "digital native" generations are neither "good" nor "bad" – they could simply be described as the new reality. It is up to the aviation industry to adapt selection and training processes to the learning needs and styles of new generations in order to continue the positive safety trends of recent decades.

### 8.3 – The MPL Instructors

In order to train the selected cadets, MPL training requires qualified instructors to deliver the training. It has been mentioned that MPL instructor training requirements are more stringent than the ones which apply to traditional training. Instructor qualifications and availability is thus another topic of debate, at least within the boundaries of EASA regulation. Instructors have been identified as probably the single most important component to success in MPL training by all of the training providers contacted. Instructor qualifications are based on the requirements in the ICAO Annex 1, and the specific MPL requirements have been placed on top of these. Therefore, there is initially a need to briefly review MPL regulations.

PANS-TRG requires special training for instructors who are to participate in a competency-based training programme. Also mentioned earlier, PANS-TRG (6.6, p.VIII, 2013) states that *"in competency-based programmes, instructor competencies are made explicit, and instructors have to demonstrate their instructional skills and their knowledge of the subject matter and training course content."* In the training requirements a list of what the instructor training should focus on can also be found. Just as the MPL training has a competency framework intended for the training of cadets, there is a similar framework for the MPL instructors which consist of the following competency units (PANS-TRG 6.1.2.6, p. 6-2, 2013).

*a) Manage safety;*
*b) Prepare the training environment;*
*c) Manage the trainee;*
*d) Conduct training;*
*e) Perform trainee assessment;*
*f) Perform course evaluation; and*
*g) Continuously improve performance.*

There are related performance criteria and competency elements as well, to be found in the PANS TRG document. However, the requirements continue, some of them being: (PANS-TRG 6.1.2.7, 6.1.2.8 and 6.1.2.9, p. 6-2, 2013)

*6.1.2.7 - Instructors providing training for the multi-pilot operations should:*
*a) Have suitable experience in multi-pilot operations; or*
*b) With the exception of instructors providing instruction in the intermediate and advanced phases of the MPL license, receive training as an alternative means of compliance with the experience prerequisite for instruction in multi-pilot operations.*

*This training should include but may not be limited to the following elements:*
*1) Multi-crew cooperation training in a suitable multi-pilot FSTD;*
*2) Observations of multi-pilot line operations with a suitable operator;*
*3) Observations of subsequent multi-pilot training where applicable; and*
*4) Completion of multi-pilot CRM training.*

*6.1.2.8 - Prior to the issue of an instructor certificate, rating or authorization, all instructors should successfully complete a formal instructor competency assessment during the conduct of practical training. The final assessment of instructor competence should be made against the competency framework*

*6.1.2.9 - All instructors should receive refresher training, and be reassessed according to 6.1.2.8 using a documented training and assessment process acceptable to the Licensing Authority, implemented by a certificated or approved organisation, or at intervals established by the Licensing Authority. This is normally done on a three year interval basis.*

In EASA regulation, the requirements are more stringent. EASA have even constructed their own competency framework with the following competency units (EASA PART FCL, FCL.920, p.46):

*(a) General. All instructors shall be trained to achieve the following competencies:*
*- Prepare resources;*
*- Create a climate conducive to learning;*
*- Present knowledge;*
*- Integrate Threat and Error Management (TEM) and crew resource management;*
*- Manage time to achieve training objectives;*
*- Facilitate learning;*
*- Assess trainee performance;*
*- Monitor and review progress;*
*- Evaluate training sessions;*
*- Report outcome.*

*(b) Assessment. Except for the multi-crew cooperation instructor (MCCI), the synthetic training instructor (STI) and the mountain rating instructor (MI), the skill test for the issue of an instructor certificate shall include the assessment of the applicant's competences as described in (a).*

The initial requirements for an MPL instructor are then made up of (EASA Part FCL, FCL.925 (a), p. 46):

*Instructors conducting training for the MPL shall:*
*(1) Have successfully completed an MPL instructor (MPLI) training course at an approved training organisation; and*
*(2) Additionally, for the basic, intermediate and advanced phases of the MPL integrated training course:*
*(i) Be experienced in multi-pilot operations; and*
*(ii) Have completed initial crew resource management training with a commercial air transport operator.*

The MPLI course therefore becomes a part of the approval process that the ATO has to put forward and this course is according to regulations made up of (EASA Part FCL, FCL.925 (b), p. 46):

*(1) The MPL instructor training course shall comprise at least 14 hours of training.*
*(2) On completion of the training course, the applicant shall undertake an assessment of instructor competencies and of knowledge of the competency-based approach to training.*
*The assessment shall consist of a practical demonstration of instruction in the appropriate phase of the MPL training course. This assessment shall be conducted by an instructor examiner.*

*(3) Upon successful completion of the MPL training course, the approved training organisation shall issue an MPL instructor qualification certificate to the applicant.*

The instructor requirements also differ depending on which phase of training is intended to participate in. A summary of those requirements can be seen in the image below.

| Phase of training | Qualification |
|---|---|
| Line flying under supervision according to operational requirements | Line training captain or TRI(A) |
| Phase 4: Advanced base training | TRI(A) |
| Phase 4: Advanced skill test | TRE(A) |
| Phase 4: Advanced | SFI(A) or TRI(A) |
| Phase 3: Intermediate | SFI(A) or TRI(A) |
| Phase 2: Basic | (a) FI(A) or IRI(A) and IR(A)/ME/MCC and 1500 hours multi-crew environment and IR(A) instructional privileges, or<br>(b) FI(A) and MCCI(A), or<br>(c) FI(A) and SFI(A), or<br>(d) FI(A) and TRI(A) |
| Phase 1: Core flying skills | FI(A) and 500 hours, including 200 hours of instruction<br>Instructor qualifications and privileges should be in accordance with the training items within the phase.<br>STI for appropriate exercises conducted in an FNPT or BITD. |

*Figure 8.3 – The EASA MPL instructor requirements (Source: EASA Part FCL, GM to FCL.925, p. 397-398)*

Explanation of terms:

(A) = Aeroplane
FNPT Flight and Navigation Procedures Trainer
BITD Basic Instrument Training Device
STI Synthetic Training Instructor
FI Flight Instructor
SFI Simulator Flight Instructor
TRI Type Rating Instructor
TRE Type Rating Examiner
MCCI Multi-Crew Cooperation Instructor
IRI Instrument Rating Instructor
ME Multi Engine
IR Instrument Rating

The head of training at CTC Aviation, Brian Haigh (2013), stated that since competency-based training still is new to most instructors, overcoming misconceptions regarding both the MPLI and CBT and trying to remove old training philosophies and methodologies has proven to be quite a significant challenge in itself. Furthermore, it would logically be hard to believe that an instructor could train a cadet to competence if the instructor does not also possess this competence, and for that reason the regulations and recommendations becomes logical. However, with such stringent instructor requirements it also becomes easy to understand why some training providers report that they are having a hard time to find qualified instructors. Also for instructors competence cannot be considered achieved by only a specified amount of flying hours. Despite this consideration, many instructor requirements remain based on hours and thus re-create a status quo that is contrary to the concept of CBT. It should be noted that the competency framework for instructors, together with requirements also for examiner and inspector qualifications, was made available on 3 May 2013 as an amendment to PANS-TRG, almost seven years after the implementation of MPL. The amendment was a result of an international working group operating in Europe in response to recognition of the lack of instructor requirements. As the MPL is a multi-crew training course it is reasonable to require instructors who have an understanding of that environment. There are alternative means to comply with the 1500 hours experience of multi-crew operation to allow for flight instructors who are not themselves multi-pilot qualified. These new means of assessing instructor competency is something that most of the current MPL programmes should consider as a possible improvement to their training quality.

Instructor requirements were also a part of the critique expressed by IFALPA at the MPL symposium. With an increased amount of training performed in simulators, Tanja Harter (2013), stated as an IFALPA representative that *"SFIs are not FIs"*- referring to the significant difference in training required to became an FI compared to a SFI and that this potentially has a consequence on training quality. The fact that requirements differ between phases also creates a potential risk to training. The CORE phase mainly consists of the single-engine piston training in smaller aircraft and as argued by Haigh (2013), this phase is extremely important as much of the fundamental knowledge and understanding of threat- and error management (TEM) is established in this phase. As instructor requirements are lower in the CORE phase, the training providers might end up using less qualified instructors during one of the most important stages of MPL training.

The Basic phase is where most training providers report that they are facing particular challenges in sourcing instructors that can meet the requirements. CTC Aviation and Lufthansa Flight Training are only two of these and LFT was at some point forced to place cadets who already had begun their training on a waiting period due to a limited number of qualified instructors available (Kröger, 2013). The challenge appears to mainly be a consequence of requiring the instructor to hold, or to previously have held, an IRI-rating together with 1500 hours of flight time in multi-crew operations. In the case of an flight instructor already being qualified to instruct on ATPL(A) or CPL(A)/IR integrated courses, the requirement of 1500 multi-crew flying hours may be replaced by the completion of a structured course of training consisting of (EASA Part FCL, FCL.905.FI (k) (3), p.50-51):

*(i) MCC qualification;*
*(ii) Observing 5 sessions of instruction in Phase 3 of a MPL course;*
*(iii) Observing 5 sessions of instruction in Phase 4 of a MPL course;*
*(iv) Observing 5 operator recurrent line oriented flight training sessions;*
*(v) The content of the MCCI instructor course;*
*In this case, the FI shall conduct its first 5 instructor sessions under the supervision of a TRI(A), MCCI(A) or SFI(A) qualified for MPL instruction.*

Haigh (2013) stated that generating a course which provides qualification for TRIs, MCCIs or SFIs that meet the requirements is very demanding. Instructor qualification was also one of the major areas identified by LFT. LFT called for a future development where the ATO itself should be approved for the design of instructor training courses. This, together with a replacement of the hour requirements, would better align qualification requirements to the CBT approach (Kröger, 2013).

Regardless of any fulfilled requirements, training quality will not be any better than the quality of the instructors' ability to pass on their knowledge and skill. As such, pedagogical skills are also brought to mind. These are skills not frequently discussed in the aviation training industry. IFALPA (2013) is one organisation who has frequently stated that there is a need to "*train the trainer"* and that a core philosophy of training is *"train like you fly in order to fly like you train"*. The instructors should thereby not only be trainers, but educators, mentors and facilitators of beyond basic aviation theory and skill.

The senior director of flight training policy at Airbus, Michael Varney, gave presentations at conferences both in London and in Montréal on how to develop instructor performance in CBT. Without competent and qualified instructors, Varney (2013) is likely right when saying that *"we are going nowhere fast"* regardless of the potential in training programmes such as the MPL. The initial question is if the industry will be able to find and maintain enough people to secure the quality of training if a pilot shortage becomes reality. In 2006 Airbus launched the APIC (Airbus Pilot Instructor Course) and in every course Airbus initially asked their participants to identify an individual which they considered to be a role model, a good practitioner and very effective instructor. On the other side of the equation they wanted to hear about their bad experiences; of trainers being incapable, not helping them to do their job and not providing the information that they needed. The statements were then gathered to reveal the results. On the bad side, some of the attributes not wanted in the instructors were:

- *Aggressive, abusive and intimidating*
- *Don't listen and talk too much*
- *Superior, arrogant and know it all*
- *Cannot observe objectively*
- *Do not have an open mind*
- *Leave the cadet guessing*

People with these attributes are still active in the aviation training industry and Varney highlighted that there is a huge cascade effect of bad practice and bad instruction by simply thinking of how many pilots and pilot cadets these instructors are involved with in training every year. The consequences are missed learning opportunities, negative training outcomes and serious long-term effects resulting in damage to the training system caused by these instructors. It is not be possible for any instructor to deliver their knowledge and experience if there is no understanding of how their instructions are being received or what the training needs actually are. Placing such an instructor into a very costly and sophisticated training tool will likely not generate the targeted training outcome. *"The art of good instruction is actually not knowing what to talk about, but knowing what to eliminate and how to build up the training content using the key features of the training course itself"* (Varney, 2013).

The goal of CBT is no more to measure an amount of hours, but to assess and evaluate a wide range of different knowledge, skills and attitudes according to defined practice. To be able to do this the cadet need to be placed at the centre of the training process. IATA (2011) states that many operators and FTOs use instructor-centred grading systems (i.e. "standard", "above standard") in their training. An instructor-centred grading directly displays the deviation of the observed performance from the norm. Although this perhaps is an efficient way for instructors and an organisation to measure performance of operational personnel, it provides very limited value to the cadet as to how to improve. If the instructors instead provide cadet-focused details into the measurement system it would be better support to the cadet by providing specific descriptors about his/her level of performance.

Regarding the question of "how" there is perhaps more than one answer. But it will most likely require a standardised approach to instruction, ensuring that the instructors are rating and assessing in the same way according to the same expectations and the same behavioural indicators. Only in a standardised form could the data collected in the evaluation system earlier described be valid and used to measure performance on not only the pilots, but also on the instructors and the system itself. It could be added that when training and developing competence the relationship and personal interaction created between the instructor and cadet at the beginning of the training session will very much affect the result of that session. Thinking about Communication, about Leadership or about Situational Awareness for instance, there is no need for flight data analysis to develop such non-technical skills – but rather a qualified, motivated and skilled instructor who is well aware of the challenges related to the specific training. The attributes identified by the APIC attendants in order to create a successful training environment and outcome were (Varney, 2013):

- *Patient and has a positive attitude*
- *Shows humility and admits mistakes*
- *Encourages and is honest*
- *Non-judgmental and shows empathy*
- *Supportive, respectful and honest*
- *Good knowledge*

From the perspective of global harmonisation there are no internationally agreed standard for selection and training of instructors and as with the MPL, the instructor expectations and demands have increased. Varney (2013) stated that there are some various ad hoc bilateral agreements, however, regulations are still to a large part prescriptive (i.e. the hour requirement of flying instructors) and some states are still completely unregulated. If the worldwide aviation industry really does strive towards greater harmonisation, standardisation of instructor performance is an important part. This is equally true for examiners and inspectors, who also need an in-depth understanding of the CBT-concept to be able to properly fulfil their part of aviation training.

### 8.4 – The MPL license rights and restrictions

To begin training towards an MPL the cadet needs to be 18 years old and hold a medical class 1 certificate. With the training completed, the privileges of the license holder is to act as co-pilot and to exercise the privileges of the instrument rating (IR) in an aircraft required to be operated with a co-pilot. The MPL training is focused on the multi-crew environment and for that reason the license does not include the privilege of flying in single-pilot operations. It is possible, however, to obtain the privileges of a PPL, a CPL and the IR for single-pilot operations provided that the training necessary to act as pilot in command has been completed with an individual skill test for each one (EASA Part FCL, 2013).

There are MPL programs that include a PPL in the first phase of training, the Core phase, but this is not a requirement although the minimum hours of actual flight coincide with the minimum to obtain a PPL (IATA, 2011). At the MPL symposium, some training providers stated that they had chosen to remove the PPL from their course content and argued that the license, conclusively being flown as single-pilot operations, steals valuable training time with the wrong focus (Jepps, 2013).

As most commercial airline operations today use aircraft certified for two pilots, the multi-crew limitation that comes with the MPL could be seen as a challenge mainly to those who are not offered employment after graduation. According to interviews with cadets who have met this challenge, most of the jobs that exist outside of the airline industry are flown in single-pilot operations, thus making it necessary to add on the single-pilot requirements to their certificate before being able to apply to these jobs. At the MPL symposium, the chief of flight operations section at the Air Navigation Bureau (ANB), Mitch Fox (2013), stated that a vast majority of the graduated MPL cadets had in fact been offered immediate employment with their host airline, suggesting that the number of cadets being concerned with this challenge has been limited so far.

However, there is another regulatory restriction with the MPL that at least training providers bound to EASA regulation seem to agree on as a limitation to the license (Lufthansa Flight Training and Swiss Aviation Training to name some). The ICAO PANS-TRG *suggests* the involvement of an airline while EASA regulation *requires* the involvement of an airline and restricts the MPL license to that particular airline until the initial operating experience (IOE) is completed (Harms, 2013). Under EASA, if a cadet fails during the IOE, the complete MPL course is considered failed, and the now still restricted license becomes useless for the cadet and may ultimately be withdrawn by the authority (IATA, 2011). In non-EASA cases the same potential problem could arise at the end of the MPL Advanced phase if no airline shows any interest in the IOE. IATA (2011) states that MPL cadets in training still are cautious regarding the pros and cons of their new license as they wish to hold an unrestricted license as soon as possible. Harms (2013) also calls for the removal of this restriction as it is considered unjust and discriminates the MPL holder compared to a traditional graduate with CPL/IR and type rating. Likewise, if the particular airline involved in the MPL training interrupts hiring, or for any other reason cannot continue as a participant during the IOE, the MPL graduate is not allowed to fly for another airline although he or she at this time holds both a license and a type rating.

Lufthansa Flight Training (Kröger, 2013; Harms (2013) proposed the creation of a "manufacturer MPL" to increase employment flexibility. This would suggest that Boeing, Airbus or any other OEM could create MPL training programmes for a specific type of aircraft. It would be interesting to find out how the approval process of such a programme would work since it is not currently possible to take pilot cadets through one approved syllabus and then send them out to various different host airlines. Each airline course has its own unique syllabus and therefore also requires its own separate approval. Also, to get "MPL" on the approval certificate, each phase also needs its respective CAA approval. This is also interesting as pilot organisations such as the ECA and IFALPA insist on the MPL being airline driven and not ATO driven (T. Harter, 2013).

An EASA working paper on "procedures in case of interruptions during MPL courses" recognises that *"recent economic downturns followed by sudden reduction in pilot needs unveil the problem in context with interruptions during MPL courses at different stages or between course completion and IOE"* (Hermansson, 2013). The paper states that blunt stopping of MPL training and waiting until economic recovery starts is not acceptable, based on the fact that the economic cycles in the aviation industry are too short, or at least shorter than the overall course length. For this reason it would be necessary to agree on a procedure for temporary interruptions of the training processes at different stages. The paper also argues that the transposition of acceptance periods and course length limitations valid for the other licenses are inadequate. Thus, possible solutions that perhaps could be an answer to the restriction are presented as (Hermansson, 2013):

*1) If exceeding of the predetermined course length is foreseeable, authority, FTO, partnering airline and student representatives convene to agree on a course of action considering the interests of all parties involves. Options like a) other type of airplane same airline, b) same type of airplane other airline, c) other type of airplane other airline, to be included in the deliberations.*

*2) The existence and application of a robust continuous assessment and grading system based on the behaviour indicators of the agreed upon pilot core competencies is an indispensable prerequisite.*

*3) The risk of a quality loss is controlled by the fact that the student in any case has to successfully pass the MPL/TR skill test, the base training and the IOE phase at a predetermined level.*

*4) MPL course length is the time from beginning of theoretical training until the successful completion of the base training.*

*5) The options below should be seen as a starting point for the discussion.*

***Option I*** *(application of the competency-based training principle)*
*1) NO definition of maximum course duration or number or length or interruption.*
*2) Competency assessment at point of resumption of training after the interruption to determine the gap between actual performance and the predetermined NORM.*
*3) Development of tailored recovery training packages to re-establish required competency level to be approved by the authority.*

***Option II***
*1) Arbitrary determination of maximum course length (5 years).*
*2) Recovery training scheme along point 2 and 3 in Option I.*

***Option III***
*1) Maximum two interruptions per course, arbitrary determination of maximum length per interruption (18 months). Breaks only between Core and Basic phase and/or between Basic and Intermediate phase.*
*2) Recovery training scheme along point 2 and 3 in Option I.*

***Option IV***
*1) Arbitrary determination of maximum length from beginning of the course until beginning of the Intermediate phase.*
*2) From the Intermediate phase until end of the course NO maximum period defined.*
*3) Recovery training scheme along point 2 and 3 in Option I.*

These solutions refers to the IOE airline lockdown, however, they rely on the ability of the training provider and regulator to accurately assess competency, where there are challenges remaining. Unfortunately, no updated information about progress or when any changes in regulation could occur has been found, but perhaps the information provided can give an indication on what to expect when changes actually do occur.

### 8.5 – The touch and go landings

Phase 4 training of the MPL ends with the skill test for both type rating and the MPL license. This in the form of base training, where the MPL cadet is required to perform a number of touch-and-go landings (TGLs) with the aircraft type for which he or she has been trained. The precise number of landings, however, depends on the regulator and this requirement is considered as one of the main drawbacks remaining with the license (as expressed by LFT and CAE). Dedicating an aircraft to just fly TGLs is a costly event for the airlines. A class of twelve MPL cadets, each required to perform twelve TGLs, makes the sum of 144 landings expensive not only in fuel and wear of the equipment, the airline also loses revenue on the simple fact that the aircraft need to be removed from commercial operations. The regulations calls for an explanation and the ICAO PANS-TRG state (Source: PANS-TRG, 3.3.4 and 3.3.5, 2013):

> *The advanced phase of an MPL training course shall include a sufficient number of take-offs and landing to ensure competency, which shall not be less than twelve. These take-offs and landings shall be performed under the supervision of an authorised instructor in an aeroplane for which the type rating shall be issued.*
>
> *The licensing authority may accept a reduction, from twelve to six, of the number of take-offs and landings required for the advanced phase of training, provided that:*
>
> *a) the approved training organisation has demonstrated to the satisfaction of the Licensing Authority that it does not negatively affect the acquisition of the required skill by the student; and*
>
> *b) a process is in place to ensure that corrective action can be made if in-training or post-training evaluation*

Summarised, ICAO recommends twelve TGLs but allows for a reduction to six if certain criteria are met. From this base-line regulators have chosen alternative approaches. Under EASA regulation, the recommendation has been replaced by a mandatory requirement – making twelve TGLs the minimum (EASA Part FCL, Appendix 5, 11, 2008). Other regulators, such as the CAAC, have made the mandatory minimum 20 TGLs before entering the IOE phase although otherwise following PANS-TRG in general (IATA, 2011 and Hongqiu, 2013). The question remains where the number twelve comes from. In a personal conversation with Dieter Harms (2013), he stated that he was one of the persons involved in this decision, but that it was a number that emerged as a result of an agreed outcome following a discussion. In other words, the number is more of an agreed “coincidence” than a validated approach. Right or wrong becomes irrelevant to discuss as today this in fact is the regulatory reality. But there are different statements on how and why regulation should change other than just the obvious financial and environmental perspectives.

Initially and while remaining with a number as reference, one of the major simulator manufacturers, CAE, gave a comment at the MPL symposium on that the number of TGLs performed in the real aircraft should not be twelve or even six, but zero (Current, 2013). The statement was based on that the high-fidelity simulators used in training today could be considered suitable to replace the actual aircraft in base training and that the competencies required could very well be assessed in a simulator. A response to this statement came from Human Factors expert, Nicki Heath (2013), who based on her experience argued that the number should not be less than three. She defended her statement with "the fear factor" and that it is essential to see how a person responds to adrenalin if the situation gets challenging and is associated with real risk. This risk would not fully develop in a simulated reality where there is no actual need to be afraid of anything. IFALPA (Harter and Macheret, 2013) describe this as MPL pilots being "children of the magenta", referring to information from the electronic flight instrument systems where the full flight simulator is their only real flight experience. Another reason was that as the sensation of "ground rush" kicks in, the cadet may return to different skills that have been learned before that perhaps would be highly inappropriate to use in the current situation, known as regression. These arguments can also be interpreted to return to the effects of transfer of training earlier mentioned. Another attendant at the MPL symposium then raised the question if it is really necessary for an MPL cadet "to fear for his life" in order to become a good pilot. A simple "yes" or "no" answer is hard to give on that question, but according to Heath it is an important aspect of training. Also at the MPL symposium, the vice chair, Licensing and Training, HUPER Committee at IFALPA, Tanja Harter (2013), in a way supported this theory in her presentation by stating that the fear factor is missing in the simulator simply by the fact that simulation is not real. She defended this with feedback gathered from IFALPA members saying; *"In a nutshell, MPL students often thinks the world is a simulation"* and that *"simulators are synthetic and not designed for basic flying"*– perhaps providing a new dimension to the debate on simulation.

As noted, many of the discussions still concern how many landings should be required based on different perspectives from different stakeholders, each supporting their own theory and experience. However, they all had one thing in common – they all used the number twelve as initial reference, which as mentioned is a number agreed on without any apparent reason. In the context of a competency-based training it becomes a matter of interest to discuss why there are a fixed number of landings at all as again, in CBT any specified number of hours or tasks is in contradiction to the principle of the CBT approach. Already in 2011, IATA confirmed that airlines quite correctly asked this question and that observed performance by the qualified training instructor should be sufficient. Some training providers presented an indication of that they completely had adopted the CBT approach in base training as well. FlightPath International, together with Ethiopian Airlines, performed up to 20 landing circuits in the simulator before doing 6 in the real aircraft the day after. The MPL cadet flew the 20 circuits with the same instructor that would accompany him or her in the aircraft the next day, to provide a support to the cadet and an appropriate assessment of the overall performance (Kordich, 2013). Although this likely is a good approach from the perspective of the cadet, the number "six" as a minimum at the same time becomes a maximum in the real aircraft. CAE and one of their partnering airline, Dragonair, stated that the number of landing required for the cadets to be deemed as competent was in average 24, compared to 20 for their CPL cadets (Jepps, 2013). For Swiss Aviation Training that same number showed an average of 13.4 for both MPL and ATPL cadets. These two numbers alone opens up for an additional discussion as it is a remarkable difference and in a way perhaps also reveals the mentioned challenges in assessing competency.

As one of the authors is an MPL cadet who also has attended MPL conferences, in a way as a representative of MPL cadets, the discussion comes across as frustrating to listen to. Although it is reasonable to agree with and understand the individual statements listed, a question that still awaits a response is the following:

If the currently specified number of TGLs is disregarded and representatives from ICAO, IATA, IFALPA, other regulators, FSTD manufacturers (since they claimed zero real aircraft landings was the target) and MPL training providers were gathered, and the MPL cadets would have asked what they need to show in regard to landing performance to be seen as competent, would it take five minutes, five hours or be impossible for them to agree? Do MPL cadets in China need to show a different competence on a Boeing 737 than the ones flying one for Lufthansa, Norwegian Air Shuttle or Ethiopian Airlines? As the training target is to train an MPL cadet to a level of competency that should be equally judged by anyone in the industry, the answer would be of interest. Pilots seem to agree on that even after years of flying a specific aircraft type having performed hundreds of landings a bad landing now and then is inevitable. This becomes interesting when reviewing the best practice guidance on pilot training from IFALPA, in which the difference between proficiency and fluency is raised. *"Proficiency may be attained after several repeats of several different events. Fluency is only attained once a manoeuvre can be properly completed after numerous repetitions, without error, over time. However, fluency is not attained until it can be determined that the manoeuvre can be performed properly after some interval of time. If the manoeuvre cannot be done properly after the passage of time, the pilot by definition is not "fluent" although he or she may be proficient after one or more repeats"* (IFALPA, 2012, p.5-6). It should be noted that fluency only needs to be applied to "critical" manoeuvres, however, the landing is of course one of those. In reference to this, perhaps the touch and go landings should be continuously assessed during the IOE instead of being performed in a set of three, six or twelve at the end of the type rating training. The number in a way becomes irrelevant if it is not able to reveal if competency has been achieved or not.

Finally, Harms (2013) argues for base training to change to the competency principle as a required future improvement of the MPL training. IATA (2011) stated several years ago that based on the reasons presented, the European MPL Advisory Board (at meeting number 7 on 24/25 November 2010) proposed that the take-off and landing issue be reviewed and be put on the agenda for future EASA rule making. In a personal conversation with the manager of the flight crew licensing section, rulemaking directorate at EASA, Matthias Borgmeier, the authors tried to get an update on the situation. Borgmeier (2013) stated that the issue remains recognised and is still being discussed, but any change to the EASA rules is a process which takes at least three to four years and as such, no immediate change should be expected. There was no indication of that such a process already had proceeded beyond the stated recognition. From this perspective it can be argued that this regulatory inertia in itself is a threat to the MPL as the ISD process relies on continuous changes and development to be made, not with years in between those changes. The number of landings is either a major obstacle, as described by many, or simply the reality as data points towards more than twelve landings being required to be deemed competent. This would support a theory that even if regulation does change and the training remain within the framework of CBT, the number of landings required will still remain above twelve.

### 8.6 – ATC challenges and language proficiency

IATA (2011, p. 6) describes that the MPL intended to address *"ongoing safety threats from poor ATC communications."* After seven years of MPL training the results from training providers actually does not point towards much improvement. Several of them report that ATC communication has been a challenge for the MPL cadets when leaving the training environment and becoming exposed to the real world during the IOE (as stated by CAE, Ethiopian, Dragonair and LUSA). Although it appears particularly challenging to the non-English speaking countries in Asia and Africa, the challenge exist in Europe as well where English is more common despite not being the native language in most countries (Fagerlund, 2013).

The MPL training emphasises more training in FSTDs than in actual aircraft, thus reducing the exposure to a real ATC environment, at best replaced by the instructor role playing as ATC. However, as there is no "requirement" of receiving for example a clearance in the simulator, it is not surprising that some elements do not get the attention they deserve, especially in demanding situations where much capacity and focus lies on different performance elements in the simulator. But the fact is that the reality of simulator training does not make it acceptable as the ongoing safety threat of ATC competency remains.

There is first of all a regulatory aspect to this problem. ICAO PANS-TRG *recommends* the provision of an ATC environment and an extract reads: (Source: PANS-TRG, Attachment A to Chapter 3, §2.2 and §3.10.2, 2013).

> § 2.2 reads: *...starting with the Basic phase of training, use of FSTDs, ranging from part-task training devices, through generic systems to full motion, full visual, high-fidelity, type specific flight simulators that also permit the introduction of interactive air traffic control environments, will begin to dominate the training...*

§ 3.10.2 reads: *The Type III FSTD (meaning the device used in phase 3) must permit the progressive introduction of a sophisticated flight environment including ATC, flight guidance systems*, EFIS, FMS and TCAS.

To this as well, EASA have implemented more stringent regulation by *requiring* the provision of an ATC environment in Phase 3 and 4 (EASA Part FCL, Appendix 5, 14, p.107-108, 2008). IATA (2011) states that design planning assumes the availability and use of modern ATC systems for almost all levels of simulators, ultimately automated using speech recognition (SR) technology. In addition, it is emphasised that these features should be applied also in the early phases with the belief in that early application of ATC system speech recognition software will accelerate the attainment of proficient aviation English level, especially where students use English as a second language (IATA, 2011). However, in addition to the regulatory issue there is initially a larger problem as such a system does not yet exist in a functional and validated form, yet it is a requirement. The previously described ICAO doc 9625 has as mentioned been extended to include the qualification and test requirements for all FSTDs and this includes the "Environment-ATC" simulator feature for the different fidelity levels Specific (S), Representative (R) and Generic (G). As the industry still awaits such a system to be finalised, doc 9625 currently reads: (Source: ICAO doc 9625 Ed.3, Part II, Attachment O)

*It is recognised that the flight simulation and training industry is currently developing technology applications and training requirements to include ATC environment simulation into FSTDs. However, the use of ATC environment simulation in FSTDs is still in the development stage of its lifecycle. Suitable guidance material will be written and published, in an update to this document when sufficient experience has been gathered and the requirements reviewed by the industry.*

While these more sophisticated ATC systems remain in a developing stage there are interim regulatory approaches such as an allowance from the NAAs for Acceptable Means of Compliance (AMC). Examples of current AMCs range from: (Source: IATA, 2011)

*a) the instructors provide structured ATC services (the legacy approach)*
*b) MPL students flying as additional crew members for a certain amount of sectors in the client airline's route network*
*c) exchanging classroom training with air traffic controller students or visiting tower (and/or approach/area) controllers at their respective job sites to get a better understanding of the interactions*

Individual training providers, such as Dragonair (Jepps, 2013), reported that they had developed an application to use with technical gadgets where the cadet could practice outside of the simulator as well. It is likely that a number of such solutions exist, but reasonably few of them will be able to accurately replace a live ATC environment. IATA (2011) argues that it is clear to an experienced instructor that any automated ATC environment system is hugely preferable to 'instructor mimicking' of ATC as it is very difficult to do so convincingly and impossible to synchronise with air traffic seen on the visual system. Such mimicking also distracts the instructor from his or hers primary task, and possibly the cadets from their focus even if ATC is to be part of the training. IATA (2011) also posted an update in 2011 stating that the technical capability exists to produce automatic ATC systems, but investment and determination are not yet at a level to complete the process in a short time scale. A couple of ATC systems are available in some of the latest FSTDs (Level D/Type VII) which synchronise ATC traffic chatter with visual traffic seen by the crew. However, full speech recognition (SR) functionality may not yet be activated as differing cadet accents are still not 'recognised' by the SR, today programmed for exact ICAO English. Suppliers of this software have indicated that they can develop individual accented SR if provided with the relevant voice files to adapt the software for each accent.

The question was also raised at the MPL symposium in December 2013 and the simple outcome is still that although technology exist it is not sufficient to be fully integrated with MPL training. Harms (2013) argued that the industry should agree on a time limit to progress the development. The reality and challenge is, as described by IATA, somewhat like "the chicken and the egg". Before the MPL have become well established in the world of aviation training with a corresponding customer demand, the investment and development of the necessary features, such as "accented" SR, may be slow and sluggish. What can be confirmed is that aviation English language training (AELT) should early be designed as one of many critical components into the MPL programme to allow for a proper personal development in flight deck communications and English proficiency.

### 8.7 – Success rates and failure protection

An interesting question despite the general challenges earlier presented is of course how the MPL has performed since its implementation or in other words – what is the answer to the earlier raised question; "is competency-based training working?" As argued, the statements and information gathered through the process of creating this report does not provide a validated or scientific foundation to argue whether the competencies have been achieved or not. Instead, the results provided is from the training providers own data and should more be considered as basic statistics of their pass/fail-rate in training.

The training providers who have taken the step into MPL training are still naturally MPL proponents. Recently the industry has been provided with numerous positive statements and organisational initiatives to promote the implementation of MPL. Out of all the current MPL trainers, Lufthansa Flight Training and their associated host airlines, Lufthansa, Lufthansa CityLine and Germanwings, alone have provided around 60% of all the airline pilots who today holds an MPL (Kröger, 2013). For that reason, LFTs statistics reasonably provides the most accurate "MPL-success-data" available at this time. In a presentation at the MPL symposium, Kröger (2013) provided LFTs data from both screening and selection and MPL training. The training data is based on 1264 cadets and their training results can be seen in the image below.


*Fig 8.7 – Lufthansa Flight Training MPL training pass/fail-results (Source: Kröger, 2013)*

The Civil Aviation Flight University of China reports a 100% success rate in their three trial courses with 35 cadets in total, together with their first host airlines Air China Southwest and China Eastern Airline (Hongqiu, 2013). As does FlightPath International in cooperation with Ethiopian Airlines in their first two courses with a total of 46 cadets (Toering, 2013). At the Lund University School of Aviation there has only been one cadet out of 45 who have not passed training and this happened as late as during the IOE, making their rate of success around 98% (Ahlgren, 2013). It should also be noted that these figures are, as far as the authors are aware of, only related to performance and cadets that have left training based on other reasons, such as free will or for medical reasons, are not accounted for. These statements could go on as all of the figures presented by the MPL training providers worldwide report success rates in the high 90%. But it also raises another important question - namely what happens to those few cadets who do not make it and what can be done to, if not to avoid a failure, at least mitigate the consequences of one.

Failure protection is relevant to discuss from both the perspective of the MPL cadet and the training provider/airline, especially due to the previously described EASA restriction. Initially, as argued by every MPL training provider and already presented as a major factor for success, the risk is in fact mitigated with a careful and rigorous selection process. At the IATA ITQI conference, the head of training at CTC Aviation, Brian Haigh (2013), argued failure protection to be one of the associated MPL challenges and necessary for the cadet as *"failure due to underperformance leaves him or her at the end of the programme with absolutely nothing to adapt to or use in commercial aviation operations."* There is also the possibility of failure from the training provider or the participating airline, as history has shown examples where the host airline went out of business or where the need for new pilots did not remain at the end of the training resulting in no employment being offered. However, different facts point towards that the statement made by Haigh may not to be entirely true. IATA (2011) state that although functional competency-based training courses should produce very low failure rates at this late stage, failures, especially in the IOE phase, cannot be excluded and coordinated "rescue-precautions" should be taken well in advance.

According to regulations the experience and flying hours acquired in an MPL course could be credited towards a different license after approval by the NAA (Hermansson, 2013). IATA (2011) suggests that one solution could be to have ATOs and operators promise to support their pilots in getting a "clean" CPL/IR license as soon as possible as a part of an eventual training contract to assure that the student may complete his education and possess a valid and unrestricted license. For this purpose special bridging arrangements to a CPL/IR are necessary and according to IATA (2011) foreseen by ICAO Annex 1. From an industry perspective it becomes relevant to question why the cadet would perform better with a CPL/IR then what he or she have done in an almost completed MPL course, or if the purpose simply is to leave the cadet with something rather than nothing.

On behalf of both the training provider and airline there is an interest in the success of cadets as both time and resources has been invested for this purpose. Another way to mitigate the risk of a failure from the airline perspective is to be involved from the selection and all the way through training. There is some feedback from MPL training in which the participating airline has more or less waited for the cadets to show up for line training (Fear, 2013). This is not optimal preparation for the cadets and a missed opportunity to raise both individual and organisational areas of improvement at a much earlier stage, before training is moved to commercial operations. In addition, there is perhaps some relevance in a personal opinion shared by Jonathan Kordich (2013) at FlightPath International who said; *"The MPL is not for airlines that only have two or three aircraft, they arguably need at least ten machines to fully function as a participating host airline."* A step closer to an improvement in failure protection would be a solution to the EASA license restriction earlier described. However, any MPL training provider should also consider developing failure protection in line with their training and local regulation if not already done.

### 8.8 – Captaincy and airmanship

A more recent challenge has appeared as some of the MPL graduates who participated in the early MPL programmes are approaching a captaincy promotion with their respective airline. From the regulatory perspective there is only a slight difference between holders of a CPL- and MPL license. In order to later acquire the airline transport pilot license (ATPL) required for the role of captain the ICAO Annex 1 reads (Source: Annex 1 – Personnel Licensing, 2.6.2, 2011):

> *The privileges of the holder of an airline transport pilot license shall be:*
>
> *a) to exercise all the privileges of the holder of a private and commercial pilot license in an aircraft within the appropriate aircraft category and, in the case of a license for the aeroplane and powered-lift categories, of the instrument rating; and*

*b) to act as pilot-in-command, in commercial air transportation, of an aircraft within the appropriate category and certified for operation with more than one pilot.*

However, when the holder of an ATPL in the aeroplane category has previously held only an MPL, the privileges of the license will be limited to multi-crew operations unless the holder has met the requirements for the CPL and/or the PPL. Any limitation shall be endorsed on the license. However, an early issue with captaincy promotion is not related to any limitation, but to the experience required for obtaining an ATPL. Here the ICAO Annex 1 reads: (Source: Annex 1 – Personnel Licensing, 2.6.3, 2011)

*The applicant shall have completed not less than 1500 hours of flight time as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a flight simulation training device is acceptable as part of the total flight time of 1500 hours. Credit for such experience shall be limited to a maximum of 100 hours, of which not more than 25 hours shall have been acquired in a flight procedure trainer or a basic instrument flight trainer. The applicant shall have completed in aeroplanes not less than:*

*a) 500 hours a pilot-in-command under supervision or 250 hours, either as pilot-in-command, or made up by not less than 70 hours as pilot-in-command and the necessary additional flight time as pilot-in-command under supervision;*

*b) 200 hours of cross-country flight time, of which not less than 100 hours shall be as pilot-in-command or as pilot-in-command under supervision;*

*c) 75 hours of instrument time, of which not more than 30 hours may be instrument ground time; and*

*d) 100 hours of night flight as pilot-in-command or as co-pilot.*

When comparing these requirements to a general MPL training curriculum it becomes clear that the prerequisites to obtain an ATPL will not likely be met during the training period as there is very limited flight time where the cadet acts as and can credit time as pilot-in-command (PIC). The cadets will not even have close to the minimum of 70 hours as PIC although most training programmes still include 80-90 hours of actual flight time (IATA, 2011) and the distance will increase if reducing these hours to the ICAO minimum of 30 as has been argued. The minimum solo time remains as 10 hours and from what was said at the MPL symposium there is no intention of reducing that requirement at this time. The alternative of course is to fly 500 hours as pilot-in-command under supervision (PICUS) instead of the alternative with a total of 250 hours if the other requirements can be met, but this then becomes costly training for the airlines.

A statement in this matter came from Jonathan Kordich (2013) at FlightPath International who said: *"It is important not to lose sight of the objective. The MPL is intended to deliver highly qualified first officers."* But Kordich (2013) was also clear about that this does not mean that the MPL first officers lack the capabilities to become qualified captains as well. FlightPath International's recommendation to their cooperating airline Ethiopian Airlines and the local aviation authorities were to let the cadets fly as PICUS. *"It will not be a benefit to the airline and their operations to send the cadets out for 500 hours of flying in the bush"* (Kordich, 2013). As studies have indicated only a small correlation between previous experience in small single-engine aircraft and performance in large commercial jets, perhaps this is true.

At the MPL symposium IFALPA called for a more pronounced bridging in the MPL towards captaincy and still referred to the MPL as a co-pilot license only (T. Harter, 2013 and U. Harter and Macheret, 2013). According to them the task analysis does not include captaincy, with selection and training therefore not being tailored accordingly. In addition, the representatives stated that IFALPA does not fully agree on the perception that small aircraft/real aircraft time is useless for airline pilots in a multi-crew environment based on the lack of "the fear factor" and the need to develop proper flying skills. There were many who did not agree and argued that the competencies in which an MPL first officer is trained does not differ to the ones required to be possessed by a captain.

IFALPA (2013) also raised a concern about airmanship, as not yet being incorporated into MPL training, although this is hard to define as it is highly subjective. To provide some clues about airmanship a summary of what the ECA include in the term "airmanship" can be found in APPENDIX 10. A brief description suggest that in order to have "good airmanship" a pilot is required to gain a deeper understanding about what affects him or her and how he or she in turn affects others, on top of a number of capabilities and competencies. IFALPA (2013) states that airmanship needs to be introduced at an early stage and continue beyond the initial MPL training. Furthermore, they state that airmanship should be acquired through mentorship and training allowing many different approaches, e.g. as observer of line pilots, case studies, structured and crew centred de-briefings, exposure to the unexpected and perhaps visits to other departments, such as ground, dispatch and ATC (Harter and Macheret, 2013). Proposed this way, there are definitely some MPL programmes that train airmanship already, at least to some extent.

There is yet no information of any MPL first officer who has been promoted to captain, but as this in time will be a reality it is likely that this discussion will resurface as it contains perspectives on both safety and economics in relation to future growth in the airline industry. Harms (2013) encouraged ICAO to launch a new state letter with re-engineered questionnaires to receive more information on the quality of the different MPL courses rather than on the quantities, including promotions of FOs to captains.

### 8.9 – MPL vs. CPL, or is it in fact MCPL?

The next relevant evaluation is to compare the MPL with the traditional CPL in those areas that can be considered comparable.

IATA (2011) stated that the MPL will not deliver a cheaper or faster program for airline pilot entry. Instead, the MPLs long-term measurable impact will be improved training quality and outcome as well as safer airline pilots from the start of their career. Naturally, a question of interest is how the MPL cadets have been received and perceived by the operators and future pilot colleagues at the start of their career in comparison to a CPL/ATPL cadet. As a parenthesis on the financial perspective of competency-based training, Harris et al., (1995, p.7) argue that those driven on by an economic rationalism sees CBT as the reform agenda that will raise the productivity levels of the workforce to internationally competitive standards. *"They see it as the means of obtaining better control of learning outcomes and, in some cases, allowing for earlier benefits from the costs of education and training, or even reducing those costs."* Initiating an MPL programme is a costly process even for an ATO which already has a traditional ab-initio programme as it requires significant investments in simulator hardware and training of instructors.

There is one version of the MPL that has not yet been covered in this report and it is referred to as the "clean" or "pure" MPL. According to Harms (2013) this approach takes full advantage of the training system. In all cases where the type of aircraft is known it uses type specific FSTD from the beginning of Phase two and would thereby have at least 50 % more training in the "real" environment compared to an MPL with generic or non-type specific devices in Phase two. In addition, when compared to the traditional integrated CPL/IR course plus type rating, it would equal at least three times more training in the "real" environment. No known MPL training provider has yet chosen to use this approach and as such this approach unfortunately cannot be compared to those already up and running.

From the training providers who have continued to run a traditional training program in parallel to their MPL training program, there is limited data for comparison. Swiss Aviation Training is one and it has showed that the ATPL cadets required an equal amount of landings during base training as the MPL cadets (Fasler, 2013). Data on students who required additional training in a simulator were 4.4% of the ATPL cadets and 4.9% of the MPL cadets. Additional training during LIFUS was 29% and 20.6% respectively. Summarised, however, Swiss Aviation Training states that there are no significant differences in quality or performance between ATPL and MPL cadets and only marginal differences in total training costs (Fasler, 2013). Another one is Dragonair who also revealed some data where the traditional CPL cadets were more effective compared to their first MPL course by requiring less sectors during the IOE to be considered qualified. As mentioned in the section covering the TGLs the MPL cadets at Dragonair also required more landings during base training than the CPL cadets. Lufthansa Flight Training stated that after check-out of the cadets there were no difference in performance between those trained traditionally and those trained by MPL (Kröger, 2013).

Initially it should be noted that both Swiss Aviation Training and Dragonair stated that they have applied competence as the way to measure progression, as in CBT, in both their traditional CPL/ATPL- and MPL training programme. Based on the challenges with CBT, this can either be interpreted as truly successful, completely impossible or as a confirmation of that the training curriculum in both MPL and traditional training have in fact become a mix of prescriptive and competency-based approaches to training. As the head of training at CAPA mentioned, they also had adjusted their traditional training by incorporating the benefits deemed suitable from the MPL curriculum. As such, and together with the fact that the data is without context, these results are hard to base any conclusion on. Any comparison should instead be made to traditional programmes not yet influenced by the competency approach.

As MPL training has been limited to ATOs with experience in ab-initio training, these equally good results could also be interpreted as a disappointment. If the benefits that the MPL is said to deliver does not show compared to how training always have been performed - could it be based on that the training in its essence remain unchanged? In a personal conversation with Dieter Harms and as an answer to the question if there were any risks associated with performing the MPL training with a task-based evaluation but within the MPL framework, he said: "*Yes, there is risk and there are some MPLs which only put a new wrapping around their old training scheme.*" The question that naturally follows but that currently is not possible to answer is of course how many this statement actually concerns. As the MPL has so far been limited to training providers with experience in ab-initio training, it would also be interesting to compare how many of those training providers actually invested in hardware and resource optimisation with the goal to improve the quality of their new training (i.e. new flight simulators or instructor training beyond the minimum requirements) and how many simply have transferred their current organisation to the new approach with existing means.

Some studies, however, point towards that the MPL has started to become more appreciated among already operational pilots. One such study analysed if the resistance and critique expressed by pilot organisations in the early development of the license affected crew functioning on flight deck. A captain with scepticism towards the MPL being forced to fly with a newly graduated MPL cadet who holds no more experience than what training has allowed him or her to obtain could theoretically create a mental model of that the performance standard of this cadet is inadequate. Such a subjective thing as "trust" is according to Mikhailov (2011) of fundamental importance for the functioning of temporary teams such as flight crews and a mistrust of the MPL concept might also cause mistrust in a pilot trained in that concept. The results of this study revealed that there were no reasons for this concern as the pilots asked stated personal abilities being more important than whatever license they hold (Mikhailov, 2011). This statement was in their opinion supported by their experience.

A more recent study made on the MPL cadets who performed their IOE with Norwegian Air Shuttle showed that some parts, such as energy management, visual flying and communication, could benefit of additional training (Fagerlund, 2013). It should be noted that this study was made by an MPL cadet and not by the airline or a training provider. However, despite some areas with room for improvement, the pilots flying with MPL cadets during training definitely felt that they were more prepared for airline operations than a traditional ab-initio cadet. FlightPath International even reported that they are now receiving statements from the pilots at Ethiopian Airlines saying that they prefer to fly with a pilot holding an MPL in preference to one with a CPL (Toering, 2013). With reference to the heavy resistance the MPL faced during the early years, this is an almost unanticipated change in perception and acceptance. Learmount (2014) stated that *"one of the truly brilliant things about the existence of the MPL is that the exercise of going back to the drawing board on pilot training has thrown into sharp relief the failings of the existing system, so in the long term the CPL training methodology will change for the better under this scrutiny."* In the opinion of the authors, reality shows that traditional training has already been altered with the introduction of the MPL and thus making any differences in training outcome harder to compare.

### 8.10 – When will the MPL be proven?

On 19 December 2013, shortly after the ICAO MPL "proof-of-concept" conference, the ECA issued a new position paper on the MPL. Some positive aspects had been identified, such as flexibility to address individual competence drifts and problems thanks to the detailed selection of cadets and continuous assessment of competencies through training monitoring and oversight. However, the overall opinion still expressed resistance towards the license (ECA, 2013, p.1):

> *"... apparent is that the already existent deficiencies in traditional training programmes are amplified in the MPL syllabus. There is less flying time in the aircraft, very limited solo flight time, and less exposure to the real environment. MPL was introduced to make pilot training more effective and relevant to the multi-crew operational environment. Care must be taken that these principles do not produce pilots who can only function within standard operating procedures and do not possess airmanship. MPL should also not serve as excuse to cut training cost."*

The conclusion in this position paper read: (ECA, 2013, p.4):

> *When MPL was introduced in 2006, it was done under following conditions:*
> *• A strong link between the ATO and the operator for the syllabus design and follow-up, to ensure a close mutual feed-back loop and to guarantee that the training is closely adapted to the airline's specific operational environment,*
>
> *• A gradual step-by-step approach for the transfer of actual flight hours to simulated hours, rather than a sudden shift, in order to allow its impact to be assessed and safety lacunae to be avoided;*
>
> *• Train the trainers concept is essential, to ensure consistency with airline operating procedures, and training instructors can act as mentors*

*• Proof of concept, i.e. MPL achieves an equivalent or higher level of safety compared to "traditional" pilot licenses and training programmes.*

*For various reasons, MPL to date has not been proven to reach the above conditions.*

In other words to the ECA, representing nearly 40 000 pilots, the MPL is not yet proven. From IFALPA, representing more than 100 000 pilots there is not yet a new position paper, however, when IFALPA gave presentations at the MPL conference much critique of "design loopholes" as they put it, was raised by their representatives. Most of these have been covered in this study as well. The MPL was shortly after summarised by the ECA on 10 January 2014 as *"7 years of MPL – 7 things learnt".* These seven bullets contained syllabi deficiencies as have been discussed, such as reducing real flying time, training for captaincy and including airmanship, lack of ATC simulation tools, the problem with being bound to a specific airline and the fact there is limited data to evaluate on. Basically, the only identified strength was the mentioned flexibility to address identified drifts. Although the highlights of this report have focused on a critical review, exploring areas that could be or need to be improved, the authors do not wish to summarise their view on the MPL as only a list of challenges and deficiencies, as it is not their current opinion after nearly a year of studies.

However, if the MPL proponents both before and during the MPL "proof-of-concept" conference in Montréal have not successfully managed to convince the world of what they consider to be the strong benefits of the concept, then when will the MPL be considered proven? This question has several answers and none of them are anymore right or wrong than the other as it appears to be highly subjective. Proponents obviously claim that it has already been proven with the large amount of positive feedback and results reported by the operators already using the MPL. Dieter Harms (2013) have been heard saying that *"the MPL is a success"* and *"from 2018 an onwards the majority of airline pilots will be trained along this route".* At the IATA conference in London in June 2013, Harms (2013) even called it a "*gross negligence"* not to implement the concepts of CBT, such as the MPL and EBT, in order to continue the decrease in accident rates and further enhance aviation safety. Based on the statements made by pilot organisations like the ones above, together with the fact that still less than one third of the ICAO contracting states have adopted MPL regulation, there is still a long way to go.

The MPL continues to gain ground in the aviation training industry, in recent time especially in Asia and the Middle East. Operators who recently have reported their intentions to commence MPL training is Japan Airlines (JAL), All Nippon Airlines (ANA) and Etihad Airways. The lead MPL instructor at the General Civil Aviation Authority (GCAA) in the United Arab Emirates, Richard Morris (2013), also reported at the MPL symposium a national projection of more than 400 MPL cadets being produced per year from 2016 and onwards.

One suggestion on when the MPL will be “proved” is that it will happen when the performance of the first 1000 graduates has been closely observed and approved (Mikhailov, 2011). Others have been heard saying that it occurs when the first MPL pilot successfully passes their captaincy exam and an additional suggestion when both the first officer and the captain of a flight holds an MPL.

From what has been found in this study changing from inventory-based qualification to one that is competency-based is a long-term endeavour. Just as regression in pilot behaviour is a threat that have caused a number of aircraft accidents, economic pressure could potentially cause regression in the training industry. Many of the training providers experienced in ab-initio training appear to be running a “MCPL” programme at this time, in other words a combination of a traditional and a competency-based curriculum. The MPL concept will however most likely eventually be seen as proven and the interesting question is simply – which version of the MPL will that be? *“ICAO does not consider the MPL validation process complete, and maybe it never should be.”* (Learmount, 2014)

## 9. RESULTS & RECOMMENDATIONS – WHAT HAVE WE LEARNED?

Before discussing the future of the MPL it is in order to summarise the results and discussions of this study to be able to give some recommendations both to the current MPL training providers and to anyone involved in the development of MPL. As expressed in the introduction, this report has not been intended as a comprehensive research project, rather as a critical analysis of the main building blocks of the MPL and the experiences gathered so far. It is with this in mind and based on the outcome of this study that recommendations are made.

Due to the expressed resistance before and during the MPL implementation, Dieter Harms was given the question "if he were to start over with the MPL implementation - what would have been done differently?" His answer was; *"More information and better guidance material."* It should be noted that this was a response to an e-mail and not a question asked during one of the personal encounters with Harms – perhaps a verbal reply would have contained even more considerations of hindsight. As misconceptions seem to have been a part of the resistance, an increase in guidance would probably have helped to some extent. However, some disbelief was associated with a lack of research and the reduction in actual flying hours, issues that would not have been resolved with additional information and implementation guidance. The questions of more relevance today concerns what has been learned during these seven years of MPL training and how those lessons should be used for further improvement. Some statements have also been made by the industry on this, as in the previously mentioned position papers issued by the ECA.

### 9.1 – Gathered general recommendations for current MPL training providers

To those training providers who are currently running MPL and continue to strive for the highest possible standards, some guidance can be extracted from the gathered feedback and will fit into regulation already in place. Some of this is not new but is relevant as a result of this study.

- When working with the programme design, using the ISD model, it is important to include everyone involved in training. It has been said several times that a successful MPL requires a close co-operation between the ATO, the host airline and the regulator. The authors encourage this and it cannot be said enough times. A fundamental aspect for the ISD approach to be fully functional is to allow for continuous development and improvement in training content and quality. If that is to yield results everyone involved – regulator, industry organisations, airlines, training management, trainers and also the students – need to participate and understand how the MPL training is intended to deliver this improvement.

- As competency-based training creates a standardisation challenge, a prerequisite for a successful program is that it is monitored closely with the necessary tools to be able to follow progression of both individual students and overall organisational performance. An evaluation of the syllabus is of vital importance in regards to monitoring if the norms are too high or low, if the training sequence is correct and if the content is relevant. There is also a need to make sure that the instructors deliver the training properly. This requires the above mentioned collaboration and the development of a continuous competency assessment system, in which the results of training can be measured and monitored to reveal strengths and weaknesses which may require potential attention. In other words, professional data management is required. The assessment system likely needs to be lesson report driven, as data can then be collected from these reports to provide continuous tracking of the cadets' performance against the pre-defined norms, of instructors grading trends and a syllabus trend analysis can be applied. As every training provider in essence also is an instructional designer, there are several solutions but minimal formal guidance available, although some criteria have been gathered in this report. Each organisation need to develop a system that works for its particular training environment.

- The selection of candidates has been highlighted as a major factor for success. Based on what was mentioned at the MPL symposium, there are now possibly also methods to test for capabilities to handle startle events. The authors agree on the mindset to "select in" rather than out and that incorporating the core competencies into the selection phase should lead to improvement also in the training outcome. In addition, English language proficiency needs to be included and developed throughout training and a minimum should be agreed and tested for when screening candidates. Training quality, however, cannot be of higher standard than by those who deliver it, regardless of the individual capabilities of cadets. Assessing and training the instructors is of equal importance. Instructor competency guidance has most recently been added to PANS-TRG and should be considered as assistance in improving training performance.

- Feedback indicates that in-cockpit CRM-related communication is working well while ATC communication suffers. The reasons to why have been highlighted and the recommendations are simply to recognise this weakness and to develop functional solutions in training that helps the MPL cadets to learn ATC communication better. Using standard phraseology is the key according to several training providers as there is not yet an answer to when ATC simulation is in place or how it will affect MPL training.

- When training the multi-crew concept and two cadets take turn flying, the logical conclusion would be that they are getting half the experience compared to if they would have been flying solo. However, a study done by Arthur, Day, Bennet, McNelly and Jordan (1997) (in Mikhailov, 2011) showed that when cadets take turn in doing the task and monitoring and giving feedback to the flying partner, they actually achieve the same level of performance making the use of a training time 100% more effective. This is called dyadic learning. In addition, Mikhailov (2011) also stated that recent research has revealed that when a trainee is paired with a high performing partner, they benefit more from the experience than when paired with low performing partner. In the context of MPL training, cadets are paired throughout different stages of the training and such dyadic learning can take place especially in the simulators where cadets take turn acting as pilot flying (PF) and pilot non-flying (PNF). This would suggest that although the MPL cadet has less solo flying hours, as a result of dyadic learning the hours that he or she instead gets will be more effective, also improving the skill retention as mentioned in the simulator topics. Furthermore, since the selection and screening process aim to find those cadets considered to have the best performance it also becomes likely that they are all high performers which should have a positive effect on training efficiency. An effective dyadic approach could also be a response to the critique that the MPL lacks in captaincy training as dyadic training creates an opportunity for MPL cadets to practice both the command and the follower role. It would also validate the use of line flying as an observer, which some providers already have integrated into their training. The potential to use aspects of dyadic learning more effectively through structured briefing and student reflection should be explored further by MPL training providers.

- MPL cadets will develop a broader understanding of the airline industry if they are given the opportunity to observe the work of those who pilots are dependent on to be able to fulfil their part in taking an aircraft to its destination. This may include observation of the work of air traffic controllers, engineers, flight operations planning staff, ground handling staff and others. This will improve the overall knowledge of the cadets regarding the context of their role and support development of a strong professional identity.

- Further explained in the next section, involving the MPL cadets themselves in the training development appears to have been overlooked by most of the training providers. The use of selected and approved cadets and cadets under training to develop existing training can be practised by simply allowing them to frequently speak their mind about how training could and should be improved. How they experience the training will play a crucial role for the training outcome, regardless of how much experience the instructors have.

- Another piece of feedback from training providers that could potentially improve cadet performance is to increase training in the following areas:
  - Energy management (i.e. visual approaches and increased descent management)
  - Raw data manual handling skills
  - Flying in conditions with turbulence and crosswind (this has been reported by some training providers, while others state that they basically have done no normal LOFT flights – again showing that evaluating and re-evaluating the syllabus for relevance cannot be emphasised enough)

### 9.2 – Gathered general recommendations for the MPL future development

For those involved with the overall future development of the MPL concept the most notable challenges derived from training experiences have been expressed in the discussion section, but there are a few aspects to add.

- In the development of the MPL, the ICAO Flight Crew Licensing and Training Panel identified a need of also reviewing the theoretical knowledge requirements but elected not to do so at that time. No change has happened since, however Dirk Kröger at Lufthansa Flight Training and Dieter Harms did raise this issue again at the MPL symposium. The authors agree that there is in a need for such a review for more than one reason. The theoretical knowledge requirements have not gone through any thorough modernisation, it is the mostly the practical aspects of training which have changed with the MPL. For the time being, the aeronautical knowledge remains as inventory-based training, validated via the conventional ATPL theory examination and this is tested via multiple-choice questions. Some parts of the ATPL theory content are still accurate while other parts are in need of an update, but in order to align theoretical and practical training and follow the MPL philosophy of CBT, event or scenario-based training perhaps could act as a replacement, at least in part. As mentioned in the section describing the eight core competencies, the additional ninth "competency" is knowledge. Knowledge act as an underpinning and necessary requirement to conduct particular training tasks in the practical lessons. Again, without knowing how in theory to perform a task will make the task increasingly difficult, if not impossible, to perform practically. Theoretical scenario-based training could work as part of lesson preparation if the necessary knowledge was referenced to in the lesson planning and description. This could match theoretical topics with practical lesson content and, although the optimal method of retrieving information of each individual is different, such event or scenario-based knowledge acquisition is likely more attractive and easier to relate to than only keeping to a lined-up theory curriculum without any affiliation to practical application. There is also the potential problem that the cadets are being trained to pass examinations, versus being trained for actual proficiency for a piloting career. As such, aligning theoretical requirements with practical performance becomes even more important. In addition, the multiple-choice questions that are used for the ATPL examinations are currently openly available at several online websites for a small amount of money, allowing any cadets to learn the questions themselves instead of the underlying knowledge. To put it simply, theoretical training needs to evolve regarding content as well as training methodology, and the examinations should be developed to also be scenario-based.

- Some comments need to be made on the discussion on simulator versus real aircraft flying time. This limited research has not provided enough validated results in order to provide conclusive evidence on this issue and at this time only a summary of different viewpoints opinions can be presented. Based on the interviews there seem to be a general opinion amongst instructors, pilots and both traditional trained cadets and

MPL cadets that simulators is a universally useful tool, fully capable of serving as a supplement to a real aircraft to train for instance procedures, teamwork or handling of failures. But there seems to be an equally shared view that the simulator, regardless of level in fidelity, cannot fully act as a substitute to the real aircraft. Still, the performance of the MPL cadets have by a vast majority been judged as equal to, or better than, the performance of those trained with traditional methods. The recommendation is simple, more research than what has been presented here needs to be performed on this matter as this discussion itself, still consisting of opinions, statements and beliefs, remains a major challenge to the future development of the MPL.

- It is not difficult to understand that the MPL have presented a major challenge to regulators. The need to train those involved in regulation on MPL is just as important as to train those who are intended to deliver the training and the authors believe that this has been identified by some in the industry, but not all. The MPL have placed many regulators in the backseat and left them relying on the training industry to lead on MPL-issues while at the same time safeguarding their own interest. Dieter Harms summarised the regulatory situation by stating that*: "It is a tedious process for various reasons – not willing to leave the comfort zone – not willing to listen – not enough suitable personal – misunderstanding of the governing principles – ignorance etc."* As such, the authors agree that regulators in general appear to lack the competence and knowledge required to regulate training that is to be run and developed with the ISD approach. Aviation is likely one the most regulated industries of all and even if there is need to keep it that way, the MPL requires a development of a more insightful and flexible regulatory approach, with enough room for the training providers to continuously evolve their training. Economy can never be ruled out as an important player in how things are allowed to function and evolve - or not function and instead devolve. The MPL is no different in this matter and financial perspectives need to be included to fully appreciate the situation. How this should be done is even more difficult to say, but perhaps an answer lies in more oversight of the training organisation and less on the training itself.

- As one of the authors is an MPL cadet, one of the things that have been most surprising is the lack of cadet perspectives in the MPL debate and development. While following the debate for over a year and having listened to the challenges associated with the MPL one remarkable observation has been made. Not once has the debate and discussion included any cadet and very few involved in the future development have been born within the range of this next generation. This becomes especially interesting when it is linked to the generational shift, as the focus shifts to the next generation of aviation professionals intended to replace the experienced retirees. At the IATA ITQI conference in London in June 2013 there was a presentation with the topic named "Experience with MPL cadets" (Kruse and Brändli, 2013). Although the content was relevant to the conference, it was to the authors' disappointment to hear the perspectives presented by training providers, from the providers own perspective only. At the MPL symposium in Montréal in December that same year, the same thing happened again. Out of hundreds of attendants there appeared to be only one MPL cadet present, namely one of the authors who seemed to be representing MPL cadets alone also in London. Most of the times any discussion arose or any mentioning about MPL cadets were made, they were referred to as "products". As if the MPL cadet is being delivered to the training providers in a box only to be stuffed with knowledge and information and later shipped on to the airline to be filled with even more knowledge. *"We have to ensure the quality of our product"*, was a repeated statement from various attendants. A question was raised to three MPL training providers after having given their presentations if they continuously collected feedback and opinions from their cadets in order to allow for improvements of the training experience. The answers indicated that it was not done. One training provider answered that they performed annual questionnaires for the cadets to fill in as an evaluation, but this was more or less all information given from these presenters. It is likely not common that cadets' are naturally interested in becoming involved with the overall development of training or aviation regulation, but are they even given the opportunity? The generational shift may come to demand also a different type of training in terms of how it is being delivered, to optimise how it will be received. In order to respond to that demand, the next generation should be consulted and involved in the training development as they are residing at the very forefront of both training and understanding and this need to be acknowledged by everyone who holds a responsibility in the development. IFALPA gave a presentation on what they felt were gaps needed to be filled in the training design, acknowledging that the next generation of aviation professionals are themselves is one vital piece in solving that puzzle.

- It seems evident that very little information on the MPL success factors and challenges have been shared between the current training providers and in order to increase the rate of development of the concept, some form of communication platform should be established where such information can be shared, preferably an online solution of some kind. In addition, re-establishing MPL advisory boards would probably also contribute to spreading the knowledge on how to improve the training. As was described in the purpose, hopefully this report can lead to an increasing engagement between the different industry stakeholders of pilot training issues and especially of the MPL.

- Finally, in order to increase the possibility of international harmonisation there should be updated published guidance material in several areas. This was highlighted by Harms (2013) at the MPL symposium and based on the outcome of this study the authors agree on that is an important step in the development.

## 10. CONCLUSIONS - THE POSSIBLE FUTURE OF THE MPL

As this study has shown, development and delivery of competency-based training in general, and the Multi-Crew Pilot Licence in particular, can be difficult and challenging in many ways. There is no doubt that the aim of the initiatives of CBT and the MPL has been to improve pilot training. Although there are currently only preliminary information to guide whether this aim has been achieved the feedback from MPL host airlines have overall been solidly positive. Beyond this, the final proof of success for the MPL over the longer term remains to be seen. There is however at this point in time no information to support that the MPL should have any significant shortcomings in comparison with traditional airline pilot training. Also, it should be difficult even for opponents of the MPL to ignore the increasingly large amount of positive feedback from host airlines that is now available. However, the question remains how training organisations will be able to effectively plan for training when predictability of time, and thereby arguably financial resources, should be of secondary importance. As economical aspects play a key role also for pilot training it is likely that the most important questions to how the MPL develops in years ahead will not only be if it provides improved pilot training, it will also be if it can be done efficiently in terms of cost or if it is mainly a better but more expensive route to the pilot profession.

From the few training providers who have reported their financial experience, indications are that the MPL ends up at similar costs as the traditional training, or only slightly higher. However, no financial conclusions can be made on such limited data. It should also be added that savings can come in many different forms, with increased safety, training quality and flexibility being some of these. This is an issue where market powers over time probably will favour the type of training that will provide the greatest benefits for the end users of the "training product", i.e. airlines and other operators. The current question is if the playing field in the pilot training industry will allow for competition between different types of training. With opponents and proponents seemingly locked in positions there is resistance as well as unsupported optimism to be found in the arguments made in regards to different forms of pilot training. However, finding a way forward in regards to pilot training is a question that should unite everyone in the aviation industry to focus on supporting further research into pilot training, especially in following up and comparison of the now available different types of training.

One of the most difficult issues of today in regards to CBT and MPL is probably if there really is any MPL training provider who actually fully runs their training according to the CBT approach. Although there are many training provides who have this as their explicitly stated ambition the conclusion of this study is that there probably is not any who fully lives up to it. Firstly, the current regulation does not allow for it to be done as there still is prescriptive regulation in place preventing it, such as the minimum amount of hours and the TGLs. Secondly, simply adjusting the previous traditional ab-initio training to a competency-based MPL environment cannot be done overnight, and likely not in the full seven years since the introduction of the MPL either. Training for competency requires a significantly developed understanding of not only all the associated concepts (i.e. what is a competency, what is TEM etc.), the knowledge and skills of the instructors also need to be developed. The importance of knowing *how* to teach is of equal importance as to *what* to teach. Adding *why* to teach also plays an important part, as motivation will affect the training outcome more than in a more traditional and more "mechanical" training environment. Furthermore, the transformation to MPL needs to be done in a joint cooperation between airlines, training providers and regulators – where each part needs to be equally motivated to implement this change positively. Knowledge and understanding of the new training methodology becomes as overarching to the regulator and training provider as TEM is to the pilots in training and at the airline.

It was industry consensus that led to the initiative to review and revise pilot training. Inventory- or task-based training had reached its limits and could in its current form probably not produce the necessary resilience in future pilots operating in an increasingly safe but complex system. In this perspective, what the MPL has is an opportunity which is not yet deployed to its full potential. The available knowledge of human performance and behaviour is vast and should influence pilot training. Beyond technical flying skills there is full recognition that individual skills, i.e. information processing, workload management and decision making, as well as team skills, i.e. communication, cooperation and leadership, are of vital importance to flight operations. Knowledge of selection as well as how to facilitate learning effectively has continued to grow and allowed for instructional techniques to develop. There are new variants of training technology to be used and in addition there is immensely valuable experience already available in the aviation training industry. Putting all of these elements together should make it possible to improve pilot training and to design the best possible training curriculum. In reality, there is a lot more work to do to come close to using the full repertoire of available resources available to move forward with pilot training. The MPL is simply one of many possible initiatives to improve pilot training and more effort will be needed to capitalise on the opportunities it provides and in doing so use the available knowledge, technology and experience in the industry.

The MPL is a developing and evolutionary process and should not be expected to provide conclusive evidence of its benefits in seven years. When the needs of stakeholders change and as research and practice reveal new problems and possibilities, CBT itself will change. When such change occurs, the intentions of CBT will hopefully affect what shape it eventually takes. All around the world, regulators are now locally changing and adapting to the current intentions of CBT. PANS-TRG says one thing. EASA has, as described, drastically increased regulation in many areas. Asian regulators have other unique requirements. If the FAA or any other regulator who have not yet approved the MPL eventually does, and also adds additional, unique prerequisites to regulation, it is not hard to understand that a global harmonisation of training standards may quickly move out of reach – or perhaps already has. CBT should preferably evolve while being mutually recognised and to be able to do this, some form of communication platform and co-branded guidance between all involved parties should be created to make sure that not every regulator, airline and ATO will have to reinvent the "MPL-wheel" and discoveries.

There is currently a multiple choice question in the ATPL mastery test in human performance and limitations that asks "Who is responsible for the safe completion of a flight?" and provides the following options:

*1) The pilot*
*2) The airline*
*3) The training provider*
*4) Everyone involved in the aviation industry*

The correct answer to this question says all that needs to be said in regards to CBT and MPL. Michael Varney (2013) probably gave the best answer to this question at the IATA ITQI conference in London, providing the perspective of an NTSB investigator from the Colgan air accident. *"When you have been on the scene of an aircraft accident and you have seen the victims in that raw state of anguish – it really brings home to you what we are doing here. We get embroiled in politics and are all about to "win the battle" and achieve whatever it is we want to achieve."* From the perspective of this study this is the same situation that the MPL currently is in – caught up in a political discussion as pilot organisations and those being unconvinced criticise the concept while proponents salute and promote it. Safety and training quality are not static parameters in a changing world, they are always improving or deteriorating. The aviation industry needs to work together and not against each other to continue improving – with the next generation of aviation professional closely involved. Several of the discussed "pilot-core-competencies", i.e. decision making, leadership, teamwork and communication, are in many areas in regards to the MPL also required outside of the flight deck in order to optimise the future development of the concept – for instance between regulators and authorities.

Finally, this study should probably be seen as an initial initiative in reviewing the MPL. It has identified several challenges with the MPL which will need to be addressed however the study also contends that the MPL is probably here to stay and that it will continue to evolve. More detailed studies need to be performed and improvement of the MPL in particular and pilot training in general will depend on the contributions, critical or supportive, of those who are involved in the aviation training industry. This will certainly mean that there will be many more arguments for and against the MPL presented by its opponents and proponents. However, regardless of position on the MPL everyone concerned with flight safety and pilot training should be able to unite behind the importance of further development of pilot training in order to maintain and improve the successful safety record of the aviation industry. This is what should be the starting point for further industry research and discussion on the MPL as well as on competence-based training and on pilot training in general.

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*On behalf of Rickard Wikander*

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APPENDIX 1 – Working paper from the ICAO FCLTP regarding the value of training future multi-crew airplane pilots in small single pilot and propeller driven airplanes
(Source: IATA, 2011, p. 109-110)

*"Cockpit design and operation of modern civil transport aeroplane and the overall environment have changed substantially over the last three decades (e.g. two-man crew, glass cockpit, fly by wire, FMS, ECAM/EICAS,GPS, Area NAV, RVSM, TCAS). There have also been dramatic developments in training media and hardware, beginning with Computer-Based Training (CBT) with system free play, part-task trainers for FMS training, system trainers or system training and fixed-base trainers for procedures training, leading up to high fidelity full flight simulators with wide screen, high resolution visual aids. There is a common understanding in the aviation community that, in order to prevent accidents and increase flight safety, the emphasis in airline pilot training has shifted from the technical to the interpersonal aspects of airline operations. Another major consideration that led to the establishment of the Flight Crew Licensing and Training Panel (FCLTP) in early 2002 was that the relevant SARPs impeded the full implementation of modern training designs, in respect to both methodology and hardware, in the ab-initio education of future multi-crew airline pilots. A major change was the need to reduce training on single-engine piston (SEP) aeroplanes with its emphasis on single pilot operations, in favor of training in an environment of operational realism, through the use of FNPT II synthetic trainers and Level D jet transport simulators. It was reasoned that pilot competencies and the underpinning technical, procedural and interpersonal attributes needed for successfully operating a modern civil jet transport multi-crew aeroplane, could not be taught on a SEP aeroplane.*

*The reduction of training on SEP aeroplanes was subject to intense discussion. Some of the participants identified basic flying skills as still being important to the development of future multi-crew pilots and, therefore, questioned the validity of reducing SEP aeroplane training. They claimed that a reduction would result in a critical degradation of basic flying skills. Such concerns, however, ignore the fact that, in spite of the continued importance of basic flying skills, interpersonal skills, such as threat and error management (TEM), communication, leadership, teamwork, workload management, situational awareness and structured decision making are more important to the successful handling of a system-degradation or to the occurrence of an abnormal situation in a multi-crew environment.*

*There is no question that future multi-crew airline pilots must have the ability to manually control a modern transport aeroplane in all maneuvers and situations. However, since the 'stick and rudder' skills for flying a multicrew aeroplane are completely different to those required to handle a SEP aeroplane, they can only be acquired in Level D simulators or in the corresponding transport aeroplane. It is not possible to train and develop these handling skills in SEP aeroplanes.*
*If it is agreed that, at high levels of stress, humans revert to the basics first learned for a specific task, then it stands to reason that basic training on SEP aeroplanes for the MPL is, beyond a certain level, counterproductive, if not unsafe. Swept-wing jet transport aeroplanes have very different handling characteristics to those of SEP aeroplanes in most regimes,*

*including a substantially greater speed range, and take-off, landing and pitch and power techniques. The ab-initio student, having thoroughly learned the basic skills needed to manually control a SEP aeroplane, very often has difficulties to re-learn and acquire the completely different basic skills needed to manually control a modern transport aeroplane. The facts show that the use of SEP aeroplanes to train multi-crew airline pilots, establish basic skills which may be hazardous if reverted to, under stressful situations, whilst flying a modern transport aeroplane. The agreement that training must be done in a sufficient amount to enable it to settle in the long term memory, also argues in favor of a substantial reduction of SEP aeroplane training for the MPL. Instead, greater emphasis has to be placed, at the very early stages of training, on the technical, procedural and interpersonal behavioral domains that are most relevant to multi-crew operations in commercial jet transport aeroplanes. Training in SEP aeroplanes should be just sufficient for the student to:*

*a) appreciate the feel of aerodynamic laws in the real environment*

*b) gain an insight into the use of aviation language, including ATC phraseology and the use of general procedures in aviation*

*c) recognize and 'believe' sensations of three dimensional movement and to develop three dimensional thinking; and*

*d) build underlying attitudes such as responsibility, self-discipline and self-confidence"*

APPENDIX 2 – Do light training aircraft hours add value to airline operations?
(Source: IATA, 2011)

APPENDIX 3 (1) – The global status of the MPL implementation
(Source: Dieter Harms, 2013)

| | | CAE / AIR ASIA | | CAPA / STERLING | | SAT / SWISS | | LFT/ LH / GWI / CLH | | CAE-OAA / FLYBE | | FTE / FLYBE | | STAA / TIGER AIRWAYS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| **Phase 1: CORE** | Hrs | 11,5 | 17 | 30 | 90 | 45 | 100 | 30 | 82 | 5 | 85 | 17 | 88 | 30 | 86 |
| | Included as Solo | | 15 | | 20 | | 30 | | 16 | | 12 | | 24 | | 16 |
| | Type | TYPE II Lvl 5 | DA-40 | FNPT I | SE/TE | FNPT II | SE/TE | FNPT I | SE | FNPT I | SE/TE | FNPT I | SE/TE | FNPT I | SE |
| **Phase 2: BASIC** | Hrs | 43,5 | 62 | 60 | | 45 | | 120 | 15 | 90 | | 60 | | 120 | |
| | Type | TYPE II Lvl 5 | DA-40 | FNPT II/MCC | | FNPT II/MCC | | FNPT II/MCC | CJ 1+ | FNPT II/MCC | | FNPT II/MCC | | FSTD IV+++ | |
| **Phase 3: INTERMEDIATE** | Hrs | 84/54 | | 20 | | 45 | | 32 | | 20 | | 60 | | 30 | |
| | Type | TYPE III Lvl 6 FFS Beech Jet | | 737 NG FFS | | EM 145 FFS | | B737/A3 20 FFS | | B737 FFS | | B737 NG Level B | | A320 FFS | |
| **Phase 4: ADVANCED** | Hrs | 12/60 | | 48 | | 52 | | 42 | | 40 | | 48 | | 40 | |
| | Type | FFS A320 | | 737 NG FFS | | A320 FFS | | B737/A3 20 FFS | | Dash 8 FFS | | Dash 8 FFS | | A 320 FFS | |
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| **BASE TRAINING (LT)** | Take off & Landings | 12 (min 6) | | min 12 | | 12+ | | min 12 | | 12 | | 12 | | 12 (min 6) | |
| | Type | B737NG / A320 | | B737 NG | | A 320 | | B737/A320/EM195 | | Dash 8 | | Dash 8 | | A320 | |
| | | | | | | | | | | | | | | | |
| **IOE** | Sectors | IAW Airline Protocols | | 40 sectors | | 50 sectors | | 40 - 60 sectors | | IAW Airline's Manual | | IAW Airlines Manual | | 30-70 sectors | |
| | Hrs (if applicable) | | | | | | | | | | | | | | |
| **DETAILS & SUMMARIES:** | | | | | | | | | | | | | | | |
| GROUND SCHOOL | Hrs | 750+ | | | | 1000 | | 1100 | | 759 | | 878 | | 800 | |
| COURSE LENGTH | Months | 14 | | 24 | | 21 | | 23 | | 16 | | 14 | | 18 | |
| **TOTAL A/C HRS** | | | 79 | | 90 | | 100 | | 97 | | 85 | | 88 | | 86 |
| **TOTAL FSTD HRS** | | 265 | | 158 | | 187 | | 224 | | 155 | | 185 | | 220 | |
| **TOTAL HRS FLT INSTRUCTION** | | 344 | | 248 | | 287 | | 321 | | 240 | | 273 | | 306 | |

APPENDIX 3 (2) – The global status of MPL implementation
(Source: Dieter Harms, 2013)

| | | TFC / AIR BERLIN | | L.U.S.A. / Norwegian Airshuttle | | ALTEON / CEA & XIAMEN Airlines | | CAFUC / Air China, Chinsa Eastern | | ALPHA AVIATION / Clark Aviation | | ALPHA AVIATION / Sharjah / Air | | Different ATOs / THAI Airways (TG) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| Phase 1: CORE | Hrs | 60 | 70 | | 69 | 67 | 67 | 30 | 80 | | 70 | | 70 | 10 | 45 |
| | Included as Solo | | 12,5 | | 30 | | 10 | | 10 | | 23 | | 18 | | |
| | Type | FNPT II | SE | | SE | FTD Lvl 5 | SE | FNPT I | SE | | C172 | | PA 28 | FNPT I | DA-40 |
| Phase 2: BASIC | Hrs | 70 | 15 | 74 | 31 | 45 | 45 | 104 | 15 | 60 | | 72 | | 40 | 40 / 25 |
| | Type | FNPT II/MCC | Piper TE Glas | FNPTII MCC | SE/ME | 737 FTD Lvl 5 | SE | FNPT II/MCC | CJ 1 | FNPT II/MCC | | | | FNPTII/ MCC | DA-40/42 |
| Phase 3: INTERMEDIATE | Hrs | 20 | | 48 | | 88 | | 48 | | 77 | | 48 | | 80 | |
| | Type | B737/A320 FFS | | B737 NG FFS | | B737 NG FFS | | A320 FFS | | A320 FBS | | A320 FBS FFS | | A320 FBS 737 FFS | |
| Phase 4: ADVANCED | Hrs | 36 | | 48 | | 92 | | 48 | | 60 | | 60 | | 60 | |
| | Type | B737/A320 FFS | | B737 NG FFS | | B737 NG FFS | | A 320 FFS | | A320 FFS | | A320 FFS | | A330 FFS | |
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| BASE TRAINING (LT) | Take off & Landings | 12 | | 12 | | 12 | | 20 | | 12 | | 12 | | 12 | |
| | Type | B737 / A320 | | B737 NG | | B737 NG | | A320 | | A320 | | A320 | | A330 | |
| | | | | | | | | | | | | | | | |
| IOE | Sectors | 60 sectors | | 100 sectors | | N/A | | 200 sectors | | to be conducted | | 80 sectors | | 100 sectors | |
| | Hrs (if applicable) | 120 hrs | | | | | | 450 hrs | | | | | | | |
| DETAILS & SUMMARIES: | | | | | | | | | | | | | | | |
| GROUND SCHOOL | Hrs | 850 | | 2 270 | | | | 900 | | 935 | | 750 | | 750 | |
| COURSE LENGTH | Months | 24 | | 36 | | 24 | | 21 | | 18 | | 18 | | 18 | |
| TOTAL A/C HRS | | | 85 | | 100 | | 112 | | 95 | | 70 | | 70 | | 111 |
| TOTAL FSTD HRS | | 186 | | 170 | | 292 | | 230 | | 197 | | 180 | | 190 | |
| TOTAL HRS FLT INSTRUCTION | | 271 | | 270 | | 404 | | 325 | | 267 | | 250 | | 301 | |

APPENDIX 3 (3) – The global status of MPL implementation
(Source: Dieter Harms, 2013)

| | | CAE-OAA / EasyJet | | CAE-OAA / Dragon Air | | AeronautX / Fly Niki | | CTC / Monarch | | Flight Path / Ethiopian Airlines | | CTC / EasyJet | | CAE / Tiger Air | | CTC / Qatar Airways | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| **Phase 1: CORE** | Hrs | 5 | 85 | 5 | 80/5 | 55 | 60 | 24 | 77 | 40 | 28,5 | 25 | 77 | | | 24 | 77 |
| | Included as Solo | | 12 | | | | | | 12 | | | | 12 | | | | 12 |
| | Type | FNPT I | C182 | C172 FNPT II | C172 /8KCAB | C172/P A44 FNPT II | C152/'P' A34 | C172 FNPT II | | DA40 | DA40 | C172 FNPT II | 5 | | | C172 FNPT II | |
| **Phase 2: BASIC** | Hrs | 90 | | 74 | 16 | 80 | | 83 | | 100 | 44 | 83 | | | | 83 | |
| | Type | FNPT II/MCC | | CRJ FNPT II | BE-90 King Air | Generic JET | | FBS A320 | | DA40, DA42, | DA40 | FBS A320 | | | | FBS A320 | |
| **Phase 3: INTERMEDIATE** | Hrs | 22 | | 20 | | 16 | | 40 | | 40 | | 40 | | | | 40 | |
| | Type | A320 FFS | | A320 FFS Level IV | | A320/E1 90 FFS | | FFS A320 | | B737NG | | FFS A320 | | FFS A320 | | FFS A320 | |
| **Phase 4: ADVANCED** | Hrs | 44 | | 44 (+44 IPT) | | 36 | 1,5 | 40 | | 20 | | 40 | | | | 40 | |
| | Type | A320 FFS | | A320/A330 FFS Level IV | | A320/E1 90 FFS | | FFS A320 | | B737NG | B737NG | FFS A320 | | FFS A320 | | FFS A320 | |
| | | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C | FSTD | A/C |
| **BASE TRAINING (LT)** | Take off & Landings | 12 | | 12 | | 12 | | 12 | | 12 | | 12 | | | | 12 | |
| | Type | A320 | | A320 / A330 | | A320/E190 | | A320 | | b737NG | | A320 | | A320 | | A320 | |
| | | | | | | | | | | | | | | | | | |
| **IOE** | Sectors | 60 sectors | | Min 66 sectors (to | | 60 | | to be determined | | to be determined | | to be determined | | to be determined | | to be determined | |
| | Hrs (if applicable) | | | A/R | | 120 | | | | | | | | | | | |
| **DETAILS & SUMMARIES:** | | | | | | | | | | | | | | | | | |
| GROUND SCHOOL | Hrs | 878 | | 575 | | 925 | | 1050 | | 833 | | 1050 | | | | 1050 | |
| COURSE LENGTH | Months | **14** | | **15** | | **14** | | **18** | | **14** | | **18** | | **16** | | **18** | |
| **TOTAL A/C HRS** | | | **85** | | **101** | | **61,5** | | **77** | **72,5** | | | **82** | | | | **77** |
| **TOTAL FSTD HRS** | | **161** | | **143(+44)** | | **187** | | **187** | | | | **188** | | | | **187** | |
| **TOTAL HRS FLT INSTRUCTION** | | **246** | | **244 (+44)** | | **248,5** | | **268** | | **272(PF)** | | **272** | | | | **268** | |

APPENDIX 4 – Behavioural Indicators used in Competency-Based Training
(Source: IATA ITQI conference, 2013)

1. Application of Procedures, **AOP**
   - *Identifies the source of operating instructions*
   - *Follows SOP's unless a higher degree of safety dictates an appropriate deviation*
   - *Identifies and follows all operating instructions in a timely manner*
   - *Correctly operates aircraft systems and associated equipment*
   - *Complies with applicable regulations*
   - *Applies relevant procedural knowledge*

2. Communication, **COM**
   - *Ensures the recipient is ready when able to receive the information*
   - *Selects appropriately what, when, how and with whom to communicate*
   - *Conveys messages clearly, accurately and concisely*
   - *Confirms that the recipient correctly understands important information*
   - *Listens actively and demonstrates understanding when receiving information*
   - *Asks relevant and effective questions*
   - *Adheres to standard radio telephone phraseology and procedures*
   - *Accurately reads and interprets required company and flight documentation*
   - *Accurately reads, interprets, constructs and responds to datalink messages in English*
   - *Completes accurate reports as required by operating procedures*
   - *Correctly interprets non-verbal information*
   - *Uses eye contact, body movement and gestures that are consistent with and support verbal messages*

3. Flight Management, Guidance and Automation, **FMA**
   - *Controls the aircraft using automation with accuracy and smoothness as appropriate to the situation*
   - *Detects deviations from the desired aircraft trajectory and takes appropriate action*
   - *Contains the aircraft within the normal flight envelope*
   - *Manages the flight path to achieve optimum operational performance*
   - *Maintains the desired flight path during flight using automation whilst managing other tasks and distraction*
   - *Selects appropriate level and mode of automation in a timely manner considering phase of flight and workload*
   - *Effectively monitors automation, including engagement and automatic mode transitions*

4. Manual Aircraft Control, **MAC**
   - *Controls the aircraft manually with accuracy and smoothness as appropriate to the situation*
   - *Detects deviations from the desired aircraft trajectory and takes appropriate action*
   - *Contains the aircraft within the normal flight envelope*
   - *Controls the aircraft safely using only the relationship between aircraft attitude, speed and thrust*
   - *Manages the flight path to achieve optimum operational performance*
   - *Maintains the desired flight path during manual flight whilst managing other tasks and distractions*
   - *Selects appropriate level and mode of flight guidance systems in a timely manner considering phase of flight and workload*
   - *Effectively monitors flight guidance systems including engagement and automatic mode transitions*

5. Leadership and Teamwork, **LTW**
   - *Understands and agrees with the crew's role s and objectives*
   - *Creates an atmosphere of open communication and encourages team participation*
   - *Uses initiative and gives directions when required*
   - *Admits mistakes and takes responsibility*
   - *Anticipates and responds appropriately to other crew members' needs*
   - *Carries out instructions when directed*
   - *Communicates relevant concerns and intentions*
   - *Gives and receives feedback constructively*
   - *Confidently intervenes when important for safety*
   - *Demonstrates empathy and shows respect and tolerance for other people*
   - *Engages others in planning and allocates activities fairly and appropriately according to abilities*
   - *Addresses and resolves conflicts and disagreements in a constructive manner*
   - *Projects self-control in all situations*

6. Problem Solving and Decision Making, **PSD**
   - *Seeks accurate and adequate information from appropriate sources*
   - *Identifies and verifies what and why things have gone wrong*
   - *Employ(s) proper problem-solving strategies*
   - *Preserves in working through problems without reducing safety*
   - *Uses appropriate and timely decision-making processes*
   - *Sets priorities appropriately*
   - *Identifies and considers options effectively*
   - *Monitors, reviews and adapts decisions as required*
   - *identifies and manages risks effectively*
   - *Improvises when faced with unforeseeable circumstances to achieve the safest outcome*

7. Situation Awareness, **SAW**
   - *Identifies and assesses accurately the state of the aircraft and its systems*
   - *Identifies and assesses accurately the aircraft's vertical and lateral position, and its anticipated flight path*
   - *Identifies and assesses accurately the general environment as it may affect the operation*
   - *Keeps track of time of fuel*
   - *Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected*
   - *Anticipates accurately what could happen, plans and stays ahead of the situation*
   - *Develops effective contingency plans based upon potential threats*
   - *Identifies and manages threats to the safety of the aircraft and people*
   - *Recognizes and effectively responds to indications of reduced situation awareness*

8. Workload Management, **WLM**
   - *Maintains self-control in all situations*
   - *Plans, prioritises and schedules tasks effectively*
   - *Manages time efficiently when carrying out tasks*
   - *Offers and accepts assistance, delegates when necessary and asks for help early*
   - *Reviews, monitors and cross-checks actions conscientiously*
   - *Verifies that tasks are completed to the expected outcome*
   - *Manages and recovers from interruptions, distractions, variations and failures effectively*

APPENDIX 5 – Threat and Error Management (TEM)
(Source: Dahlström, Laursen and Bergström, 2009, p.20-29)

TEM is a relatively new concept within aviation Human Factors and one which has received considerable attention in recent years. The concept has been described in many different ways, including it being a new generation of CRM or even an alternative to CRM. Several airlines have partially adapted their CRM courses and other aspects of their operations to TEM, e.g. in regard to checklists and manuals. The ICAO (International Civil Aviation Organization) has prepared guidelines intended to make training in TEM mandatory for some categories of operators. TEM is also included as an integrated part of the new MPL (Multi-crew Pilot License).

Even if it may not yet be entirely clear as to what TEM is (or is intended to be), it is reasonable to consider it as a general systematic approach and tool for flight safety and for how risks in operations can be identified and resolved. TEM thus constitutes a framework for CRM within which various parts of CRM (such as information management, communications cooperation and leadership) can be used for dealing with the threats and errors which are present in operations.

TEM was developed by the University of Texas Human Factors Research Project (UTHFRP), along with a method for producing information about operations called Line Operations Safety Audit (LOSA). TEM and LOSA have been received by both regulatory agencies and airlines around the world as valuable tools for maintaining and improving flight safety (although the response in Europe has been less accommodating than in other parts of the world). It is therefore logical to begin with a description of LOSA to later be able to explain TEM's background and purpose.

**2.1 Background – Line Operations Safety Audit (LOSA)**

LOSA (Line Operational Safety Audit) is a method for collecting information about operations that may not be available from other information sources connected to operations, flight training or audits. The method is based on the assumption that these other information sources may not be providing a complete picture of daily operations, i.e. the assumption that there always are differences between how operations are intended to be performed and how they actually are performed. This can be illustrated with the following figure:

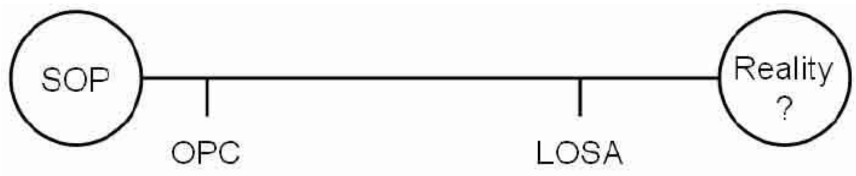


*Figure 2.1.1. Illustration of LOSA's role*

In this case the understanding of operational activities is based on that even though regulations, procedures and routines are intended to cover all situations, they do not. Furthermore, crews and organizations will always attempt to carry out operations in spite of any adversities. Taken together, this can result in deviations from rules, procedures and routines that create risks, but which in specific situations may be effective and safe ways of adapting operations to altered circumstances or new situations. Such deviations may be revealed to management through reporting, observations during flight training or, for example, in OPCs (Operator Proficiency Checks). Because the latter is an "examination" situation, however, it is unlikely that deviations will be revealed during OPCs particularly often. Even if information about deviations can be acquired through reporting and flight training, in most cases this will represent information concerning isolated cases. This means that it can be difficult to motivate changes to operations based on such information.

LOSA is based on accompanying observers taking notes on the threats and errors that occur during flights, as well as on how these threats and errors are managed. Accepting an observer on a flight is a voluntary decision, made by the crew. Normally observations and reports from a large number of flights are collected during the period that LOSA is performed. The reports from the observers are compiled in a database from which information can be produced, analysed and presented in various ways. This can provide an operator with information about the most commonly occurring threats and errors in daily operations. Moreover, comparisons can be made with other operators to see which differences exist. This information can be further analysed and result in proposals for changes of procedures, training, organizational structure or other factors that affect operations. Because LOSA involves a large number of flights, decision-makers are provided with a material that can justify changes to operations.

Among the airlines to implement LOSA early were Delta and Continental. Others that have implemented LOSA are Singapore, Cathay and Emirates. Several airlines have already conducted a second LOSA to find out if changes which were implemented after the first one have produced the desired results. Continental followed up its initial LOSA in 1996 with a second in 2000. The following are comments from Captain Don Gunther, Senior Director of Safety & Regulatory Compliance at Continental in regards to its second LOSA:

> The 2000 LOSA, when compared to the results of 1996, showed the pilots had not only accepted the principles of error management but incorporated them into everyday operations. LOSA 2000 showed a sizeable improvement in the areas of checklist usage, a 70 percent reduction in nonconforming approaches (i.e., those not meeting stabilized approach criteria), and an increase in overall crew performance. It could be said that Continental had taken a turn in the right direction.

That LOSA has been accepted by the aviation industry has resulted in ICAO promoting prepared guidelines for how information from daily operations can be gathered and used to improve flight safety. These guidelines refer to “Normal Operations Monitoring”. Even if such monitoring can be performed in various ways, LOSA is the only accepted method to date and is even recommended as industry best practice. (The equivalent to Normal Operations Monitoring for ATC is Normal Operations Safety Survey, NOSS.) An intention has also been expressed by ICAO to make Normal Operations Monitoring (in practice LOSA) mandatory for some categories of operators, certainly for major international carriers.

According to ICAO, there are ten operational characteristics specifying the conditions that must be fulfilled to ensure that collection of data from operations will produce results that are sufficiently reliable to be used for improving the safety of an operator. These ten conditions are of equal importance for successful implementation and all must be fulfilled for the collection of information to be considered as a LOSA. These ten conditions are that data collection shall be based on:

1. Jump seat observations during normal flight operations.
2. Anonymous and confidential data collection
3. Voluntary flight crew participation
4. Joint management / pilot association sponsorship
5. Safety-targeted data collection form
6. Trusted and trained observers

7. Trusted data collection site
8. Data cleaning roundtables
9. Data-derived targets for enhancement
10. Results feedback to line pilots

The resulting report of a LOSA may be about 60 pages long and include an account of collected data by use of various statistical methods presented in different types of tables and diagrams. These present the occurrence of threats and errors in operations, as well as to what extent they are resolved by crews. For the observations, there are usually not just categorizations in terms of threats and errors, but also more detailed descriptions of observed incidents. This is important, since it can be difficult to categorize an observation, and with a description available, the initial categorization can be evaluated and modified on a later occasion.

The LOSAs that have been gathered by the LOSA Collaborative, an organization founded by the University of Texas, are stored in the LOSA Archive. This archive is constituted by a database that contains anonymous data (in regards to individuals and airlines) from all airlines that have performed a LOSA in cooperation with the LOSA Collaborative. The database is intended to be used for use research. The following collected data was in the LOSA Archive for the period 2002 to 2006:

- LOSAs from 25 airlines
- 4,532 observation occasions
- 19,053 categorizations of observed threats in conjunction with operations
- 13,675 categorizations concerning crew errors in conjunction with resolving threats
- 2,589 occasions when threats and errors were not appropriately resolved and resulted in undesired aircraft states.

To summarize, LOSA can be described as a method for systematically collecting information from normal operations for the purpose of acquiring a picture of the threats and errors which impact on flight safety. LOSA can thus be seen as a way of dealing with risks in flight operations by attempting to identify them before they result in reports from incidents or other safety related occurrences in operations. Implementation of LOSA can result in improvements to operations in regard to flight safety and consequently in reduced insurance costs, especially as the results in the reports are being presented in a form (data processed with statistical methods) which appeals to insurance companies. It is also worth emphasizing that some airlines (such as VARIG) have independently conducted LOSAs without direct collaboration with the University of Texas.

## 2.2 Threat and Error Management (TEM) – Concept and model

TEM's origin is closely related to that of LOSA. Concurrent with the development of LOSA, the first observation form for evaluation of behaviors linked to CRM was created. The form was later expanded to cover crew errors and how these were managed by the crews. Observing an error, without observing the conditions under which it occurred, makes it difficult to understand what happened in conjunction with the error. Also, this does not provide sufficient information to support learning from the error. Threats and management of threats were therefore included on the observation form to provide a description of the entire sequence of events, which in the worst case can escalate from a threat to an accident.

The three basic concepts in the TEM model are “threats”, “errors” and “undesired aircraft state”. The concept of threats refers to external conditions that endanger flight safety during flight operations. Threats can be defined as:

Events or errors that:
- Occur outside the influence of the flight crew (i.e. not caused by the crew)
- Increase the operational complexity of a flight
- Require crew attention and management if safety margins are to be maintained

Threats in conjunction with commercial aviation are divided into two primary categories: environmental threats and airline threats. These in turn can be divided into subcategories, which are presented below with examples:

Environmental threats:
- Weather – Thunderstorms, turbulence, poor visibility, wind shear, icing conditions, IMC
- Airports – Poor signage, faint markings, runway/taxiway closures, INOP navigational aids, poor braking action, contaminated runways/taxiways
- ATC – Tough-to-meet clearances/restrictions, reroutes, language difficulties,
- controller errors
- Environmental operative pressures – Terrain, traffic, TCAS TA / RA, radio congestion

Airline threats:
- Aircraft – Systems, engines, flight controls, or automation anomalies or malfunctions; MEL items with operational implications; other aircraft threats requiring flight crew attention
- Airline operational pressure – On-time performance pressure, delays, late arriving aircraft or flight crew
- Cabin – Cabin events, flight attendant errors, distractions, interruptions
- Dispatch/Paper work – Load sheet errors, crew scheduling events, late paperwork, changes or errors
- Ground/Ramp handling – Aircraft loading events, fuelling errors, agent interruptions, improper ground support, de-icing
- Ground maintenance – Aircraft repairs on ground, maintenance log problems, maintenance errors
- Manuals/charts – Missing information or documentation errors

Some threats can be anticipated while others cannot, such as those that occur suddenly and without warning. Furthermore, some threats are latent and impossible to directly identify or observe by the crew. Environmental threats can either be predictable or non-predictable (and thus must be resolved as they occur), while airline threats can usually be contained (eliminated or minimized) within the organization responsible for operations.

A threat which is not managed properly is connected to crew error (simply since it was not properly managed), in other words, an inappropriately managed threat constitutes a crew error. We have now arrived at the next concept in TEM, “errors”, which are defined as follows:

An error is defined as flight crew actions or inactions that:
- Lead to a deviation from crew or organizational intentions or expectations
- Reduces safety margins
- Increases probability of adverse operational events on the ground or during flight

Errors are also divided into a number of categories. General descriptions of these categories, along with examples of each, are provided below:

Aircraft handling errors

- Automation – Incorrect altitude, speed, heading, autothrottle settings, mode executed or entries
- Control systems – Incorrect flaps, speed brakes, autobrake, thrust reverser or power settings
- Ground navigation – Attempting to turn down wrong runway/taxiway, missed taxiway/runway/gate
- Manual flight – Hand flying vertical, lateral, or speed deviations, missed runway/taxiway failure to hold short, or taxi above speed limit
- Systems/radios/instruments – Incorrect pack, altimeter, fuel switch or radio frequency settings

Procedural errors

- Briefings – Missed items in the brief, omitted departure, takeoff, approach, or handover
- Callouts – Omitted takeoff, descent, or approach callouts
- Checklists – Performed checklist from memory or omitted checklist, missed items, wrong challenge and response, performed late or at wrong time
- Documentation – Wrong weight and balance, fuel information, ATIS, or clearance recorded, misinterpreted items on paperwork
- Pilot Flying (PF)/Pilot Not Flying (PNF) duty – PF makes own automation changes, PNF doing PF duties, PF doing PNF duties
- SOP cross-verification – Intentional and unintentional failures to cross-verify automation inputs
- Other procedural errors – Other deviations from government regulations, flight manual requirements or standard operation procedures

Errors regarding communications

- Crew to external - Missed calls, misinterpretation of instructions, or incorrect readbacks to ATC, wrong clearance, taxiway, gate or runway communicated
- Pilot to pilot – Within-crew miscommunication or misinterpretation

Lastly, there is the concept of “undesired aircraft state”, which is defined as follows:

An undesired aircraft state is a position, speed, altitude or configuration of an aircraft that:

- Results of from flight crew errors, action or inactions
- Clearly reduces the safety margins

Various types of undesired aircraft states are categorized as follows:

- Aircraft handing – Vertical, lateral or speed deviations, unnecessary weather penetration, unstable approach, long, floated, firm or off-centreline landings
- Ground navigation – Runway/taxiway incursions, wrong taxiway, ramp, gate, or hold spot, taxi above speed limit
- Incorrect aircraft configuration – Automation, engines, flight control systems or weight/balance events

The fundamental idea of the model is that threats and errors, as well as management of these, are part a part of everyday operations for a crew. Management can however be optimal or less than optimal and lead to an undesired aircraft state. An undesired aircraft state may in worst case induce the risk for an accident. Errors and undesired aircraft states should be managed by detection and application of procedures in order to return to controlled and safe flight. Management of undesired aircraft states constitutes the final opportunity to avoid reduced safety margins during flight.


*Figure 2.2.1. Illustration of the TEM model*

The TEM model can be illustrated as in figure 2.2.1. At the top is the concept of threats. To manage threats and subsequently avoid errors, there are various strategies, such as pre-flight briefings (including weather forecasts and NOTAM), inspections of aircraft prior to flight, cooperation with cabin crew regarding suitable times to enter the cockpit, procedures for resolving technical problems, in-flight briefings (e.g. in the case of a runway change) and adding extra fuel in regards to uncertainties at destination or alternate airports.

If threats are not properly managed using available strategies, they can lead to errors. While threats exist or arise beyond the control of the crew, errors originate from the way in which the crew carries out its duties (even if errors of other people, such as mistakes by ATC or technical personnel, can constitute threats to the crew). A decision to not add extra fuel for a flight to a destination where weather or other conditions are uncertain factors can lead to problems, and is therefore an error. (In this case, operator guidelines for fuel or the method for fuel calculations can constitute a threat that contributes to this error).

In managing errors, there are two different levels available – countermeasures (resist) and problem-solving (resolve). Resist refers to preparations, technical systems, instructional information or other resources that contribute to resolving errors before the crew must find a way of resolving them on their own. A countermeasure can be training of scenarios in simulators, technical warning systems (such as GPWS or ACAS/TCAS), as well as manuals, procedures and checklists, and ATC or technical support from the ground.

If countermeasures are insufficient to manage an error, the crew must attempt to manage the error with the resources available to them as crew members (resolve). This means that they have to rely on their own capabilities relating to, e.g. information management, effective communication, cooperation and leadership, as well as on their experience to manage the error.

If this also would be insufficient for successful management of threats and errors, or if applied solutions are incorrectly performed, the consequence can be an undesired aircraft state and reduced safety margins for the flight. This situation must then be managed by the crew, and in such a situation, the capabilities of the crew, e.g. in handling of aircraft in abnormal situations, will be crucial to regain the desired safety margins.

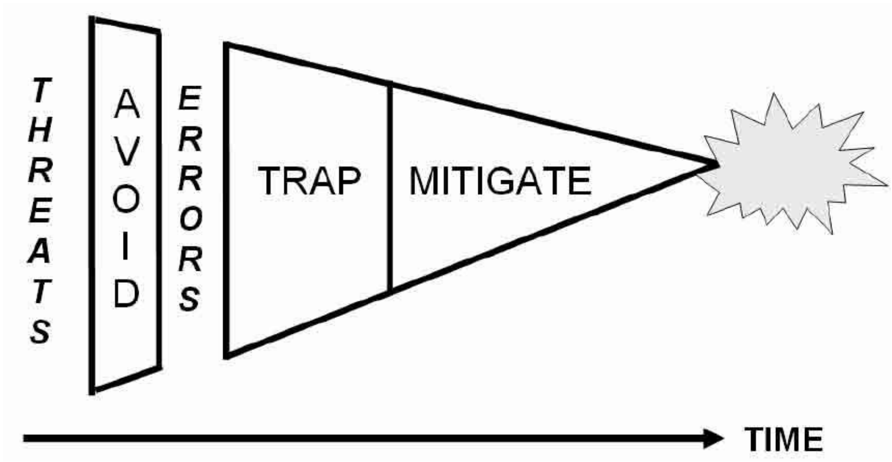


*Figure 2.2.2. Alternative illustration of TEM model*

A different way of presenting the TEM model that is used in CRM training is shown in figure 2.2.2 above. In this case, the concepts “avoid”, “trap” and “mitigate” are used, which also originate from the University of Texas. The focus here is primarily on how threats can be avoided long before they result in errors or undesired aircraft states, on how errors can be trapped shortly before or in concurrent with them occurring and on how consequences of errors can be mitigated. This model can be illustrated by the management of the threat of thunderstorm activity. If such activity is mentioned in a weather forecast, the planned route can be changed prior to the flight and the problem can be avoided. If the thunderstorm activity is discovered during flight, the problem can be trapped and the option of flying around it may still be available. If it is not discovered until the aircraft has entered into it, the only option left may be to mitigate the consequences by choosing a different altitude and putting the seatbelts signs on. Fatigue can be used for another illustration of this model. When a pilot sees on his roster that there are a high number of night flights scheduled during a certain period he can request a roster change to avoid problems with fatigue. If this is not done, the pilot can trap the problem by resting before a flight (or, if possible, use “controlled rest” during the flight). If the pilot gets fatigued during flight, the only remaining option may be to mitigate the consequences, e.g. by drinking coffee.

The TEM model constitutes a framework for understanding events that can affect safety margins during a flight. This means that it can be used in several different ways, such as:

• *Training*

TEM constitutes a framework within which CRM training can be linked to the occurrence of various errors and threats within an organization. CRM training can thus be oriented towards the areas in which it can most effectively contribute to increasing the abilities of crews to deal with threats and errors.

• *Reporting*
Reporting forms configured according to the TEM model create a structure in which crews can describe incidents using the concepts of threats and errors, and thereby facilitate their understanding of the events which have occurred and their possibilities for describing it.

• *Analysis*
The TEM model can during an analysis of an occurred incident contribute to the focus being shifted from the individual incident to an understanding of more general systematic problems, for example, through the model's close association with LOSA.

TEM and LOSA are based entirely on the same concepts and structure in explaining how flight safety can be negatively affected by threats and errors. Together these constitute the currently most widely spread methods for working with flight safety issues. More airlines are planning to implement LOSA and several intend to carry out second or third LOSAs to follow up and continue the work they have begun.

To summarize, the intention of the TEM model is to describe and create an understanding of how a crew work with planning and executing a flight can be affected by various conditions and events. As a model, TEM can be used for preventive purposes, for reporting or for analysis of occurred incidents on individual or organizational level.

**2.3 Criticism of TEM**

The acceptance that TEM and LOSA have received in the aviation industry during a relatively short time indicates that they represent important tools for current work with developing and improving flight safety. Even though they can by no means still be considered as new tools, there is still considerable criticism regarding several aspects of them. This criticism is presented here because it can contribute to increased understanding of the limitations and weaknesses of the TEM model and LOSA as a method. Armed with such an understanding, an operator can avoid the risk of using TEM and LOSA in a manner that does not effectively contribute to increased flight safety or choose to find other models and methods to improve flight safety.

An often mentioned criticism of TEM is that the model only represents the way in which all pilots have always approached flight safety, in the form of questions such as: What can cause problems for a planned flight (threats)? What can these lead to (errors)? How can these be managed (threat and error management, meaning TEM)? According to critics, TEM only contributes to the conceptual model that all pilots have applied since the early days of aviation with a more academic and difficult language. The apparent simplicity of the model, as it has been presented at international conferences, is also contradicted by the more complicated flow chart for it which has been presented in scientific papers. It thus seems that its promoters are simultaneously attempting to both emphasize the simplicity of the model (and consequently, how easy it is to understand) and its complexity (and consequently, how well it represents reality). Regardless of whether this criticism is entirely justified, it can still be said that TEM can contribute with standardized terminology and a structured approach to use this perhaps already well established mental model of pilots and the TEM model can subsequently facilitate development and progression in regard to flight safety issues.

When it comes to LOSA, there has been criticism based on, among other things, that it is an unnecessary time-consuming and resource-intensive method of collecting data from normal operations. Alternative methods for this could comprise collection and analysis of data from:

- Line checks
- Flight data monitoring
- CRM skill assessments
- Reporting (mandatory, voluntary, confidential or other type of reporting)
- Focus groups (discussions with small groups which can be considered to represent the views of larger groups)
- Crew interviews
- Questionnaires to crews

The criticism is based on that the same information content that is obtained from LOSA can be produced just as effectively with the methods above but using less of resources and at a significantly lower cost. The resources and money that then would be available could subsequently be used to actually resolve identified problems, e.g. by increasing time for flight training in simulators or to increase other training.

It should be kept in mind that crews have the right to deny a LOSA-observer from accompanying them on a flight. For some LOSA-projects there have been a high number of denials. It is not unreasonable to question why crews would not let an observer accompany them and how data from these flights could have affected the conclusions drawn from the data that was collected. In this context, there may also be reason to question the influence of an observer's presence on crew behavior during flights. A very simple but convincing argument advanced by pilots at airlines that have conducted LOSA has been that it if management had only have taken the time to create a secure environment for discussion, they could have obtained the same information directly from the pilots.

Another point of criticism in regards to TEM and LOSA is based on questioning of the degree to which it is possible for an accompanying and passive observer to identify and categorize errors during a flight. The criticism regarding TEM consequently concerns whether there is consensus as to what an "error" is. For starters, LOSA is based on the assumption that flights are often conducted in a way that differs from only following procedures. Nonetheless, an observer is supposed to be able to identify what constitutes an "error" in the crew's behavior in a given situation. In the same way, it is decisive for TEM that "threats" and "errors" can be identified for the model to be meaningful. A problem is that management of a threat or error cannot commence until the threat or error has been identified, and how identification is to be accomplished is not specified by TEM. Moreover, one crew's error can be another's way of avoiding threats and errors. For example, crews can be hesitant in contacting ATC because of the knowledge they have of ATC workload based on experiences from previous flights. They thus avoid a situation in which they are forced to wait for ATC response and risk forgetting the contact they have taken. Whether this is to be considered as an error or an effective adaptation to actual operational conditions can be difficult to determine. For each clear case of a possible error that a crew can make, grey zones can also be imagined in which it can be difficult or impossible to determine if an action is an error, or whether an action that prevents later threats and errors constitutes an error.

Additionally, the division between threats and errors in the TEM model is not always easy to bring in line with everyday use of language. If threats are external in relation to the crew (they come at the crew) and errors are internal (they come from the crew), how should a private problem that affects a pilot be perceived? Is this external even if it affects the pilot's thought processes? Is it a threat or error if the pilot is thinking about private problems prior to or during a flight? Even if these questions can be answered by someone who is experienced in applying the TEM model, they are examples of how it is not always easy to interpret the world by using the concepts provided by the model.

It is also important to emphasize that TEM in no way replaces CRM. Viewed favorably, TEM constitutes a framework for understanding operations and their associated risks, and can thereby contribute to directing attention to the areas in which CRM training can best equip crews with tools for handling these risks. All areas taken up in CRM training according to the regulations must still be addressed. Information about risks in operations based on various information sources (where LOSA is one of many possible), combined with a structured approach to these risks (TEM is one such in this context), improves the preparatory framework for performing effective CRM training. Unfortunately, TEM and CRM are all too often confused with one another. Even if training in TEM can be integrated with CRM training, these two concepts do not represent the same thing.

Because all descriptions of reality are simplifications, the final judgment is not actually focused on whether TEM is faultless, since no model can represent all aspects of reality. The judgment that must be made is whether the TEM model increases understanding of risks in flight operations and whether it is a more effective tool for maintaining and improving flight safety than other models or methods that can be applied for this purpose.

APPENDIX 6 – Example of the Instructional Systems Design model (Source: Clark, 2013)

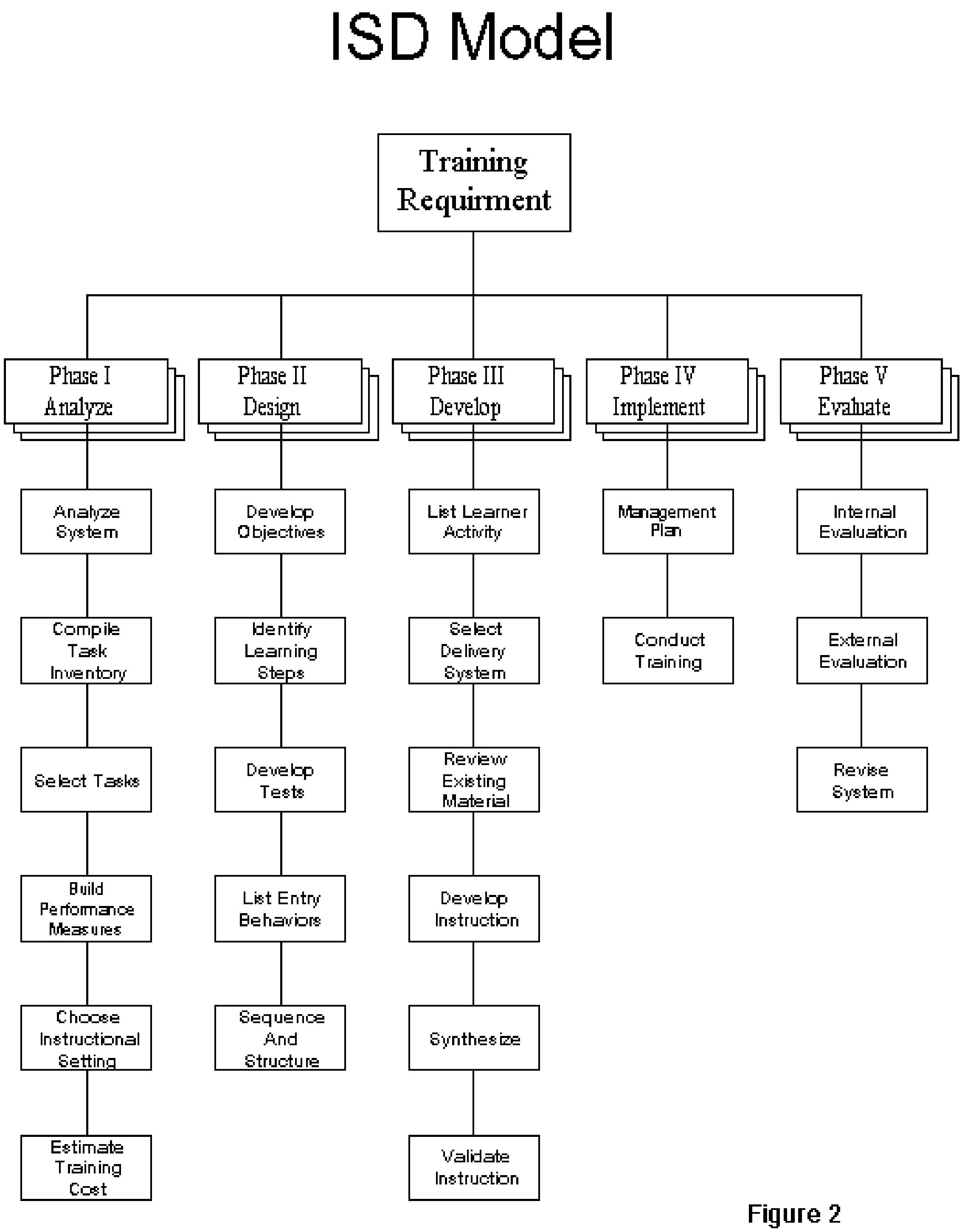


Figure 2

# APPENDIX 7 – FSTD requirements for MPL phases
(Source: ICAO doc 9625, 2009)

| Licence or type of training | ICAO FSTD | T/TP | Cockpit Layout & Structure | Flight model (Aero & engine) | Ground Handling | A/C Systems | Flight controls and forces | Sound Cue | Visual Cue | Motion Cue | Environment - ATC | Environment - Navigation | Environment - Weather | Environment - Airports & Terrain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MPL4 - Advanced | | T+TP | S | S | S | S | S | R | S | R | S | S | R | R |
| TR+ATPL | | TP | S | S | S | S | S | R | S | R | S | S | R | R |
| Re | VII | T | S | S | S | S | S | R | S | R | N | S | R | R |
| RO+IO+CQ | | TP | S | S | S | S | S | R | S | R | S | S | R | R |
| RL | | TP | S | S | S | S | S | R | S | R | S | S | R | R |
| MPL3 - Intermediate | VI | T+TP | R | R | R | R | R | R | S | R1 | S | S | R | R |
| ATPL/TR/IO/RO/RL | V | T | S | S | S | S | S | R | R | N | G | S | R | R |
| MPL2- Basic | IV | T+TP | R | G | G | R | G | R | G | N | G | S | G | R |
| CR | III | T | R | R | R | R | R | G | R | N | N | S | G | G |
| IR | II | T | G | G | G | R | G | G | G | N | G | S | G | G |
| CPL | | T | R | R | R | R | R | G | R | N | N | S | G | G(S) |
| MPL1 - Core flying skills | I | T | R | R | R | R | R1 | G | G | N | N | S | G | G |
| PPL | | T | R | R | R | R | R | G | R | N | N | S | G | R(S) |

APPENDIX 8 – Example of FSTD task training requirements for MPL phase 1
(Source: ICAO doc 9625, 2009)

| MPL1 (T) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source | Competency Element or Training Task | Cockpit Layout & Structure | Flight model (Aero & engine) | Ground Handling | A/C Systems | Flight controls and forces | Sound Cue | Visual Cue | Motion Cue | Environment – ATC | Environment – Navigation | Environment – Weather | Environment – Airports & Terrain |
| ICAO | 2.3 Perform pre-flight checks and cockpit preparation | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 2.4 Perform engine start | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 2.5 Perform taxi out | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 2.6 Manage abnormal and emergency situations | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.1 Perform pre-take-off and pre-departure preparation | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.2 Perform take-off roll | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.3 Perform transition to instrument flight rules | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.4 Perform initial climb to flap retraction altitude | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.5 Perform rejected take-off | R | R | R | R | R1 | G | G | N | N | N | G | G |
| ICAO | 3.6 Perform navigation | R | R | N | R | R1 | G | G | N | N | S | G | G |
| ICAO | 3.7 Manage abnormal and emergency situations | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 4.2 Complete climb procedures and checklists | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 4.3 Modify climb speeds, rate of climb and cruise altitude | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 4.4 Perform systems operation and procedure | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 4.5 Manage abnormal and emergency situations | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 5.1 Monitor navigation accuracy | R | R | N | R | R1 | G | G | N | N | S | G | G |
| ICAO | 5.2 Monitor flight progress | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 5.3 Perform descent and approach planning | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 5.4 Perform systems operations and procedures | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 5.5 Manage abnormal and emergency situations | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 6.1 Initiate and manage descent | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 6.2 Monitor and perform en route and descent navigation | R | R | N | R | R1 | G | G | N | N | S | G | G |
| ICAO | 6.5 Perform systems operations and procedures | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 6.6 Manage abnormal and emergency situations | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 7.1 Perform approach in general | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 7.5 Monitor the flight progress | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 7.6 Perform systems operations and procedures | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 7.7 Manage abnormal and emergency situations | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 7.8 Perform go-around / missed approach | R | R | N | R | R1 | G | G | N | N | N | G | G |
| ICAO | 8.1 Land the aircraft | R | R | R | R | R1 | G | G | N | N | N | G | G |

APPENDIX 9 – Example of FSTD task training requirements for MPL phase 4
(Source: ICAO doc 9625, 2009)

MPL4 (T)

| Source | Competency Element or Training Task | Cockpit Layout & Structure | Flight model (Aero & engine) | Ground Handling | A/C Systems | Flight controls and forces | Sound Cue | Visual Cue | Motion Cue | Environment – ATC | Environment – Navigation | Environment – Weather | Environment – Airports & Terrain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICAO | 2.1 Perform dispatch duties | S | N | R | S | N | N | N | N | N | S | G | N |
| ICAO | 2.2 Provide flight crew and cabin crew briefings | R | G | G | R | G | R | G | N | G | N | G | R |
| ICAO | 2.3 Perform pre-flight checks and cockpit preparation | S | N | R | S | S | R | N | N | S | S | G | N |
| ICAO | 2.4 Perform engine start | S | S | S | S | S | R | N | N | S | S | R | N |
| ICAO | 2.5 Perform taxi out | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 2.6 Manage abnormal and emergency situations | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 2.7 Communicate with cabin crew, passengers and company | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 3.1 Perform pre-take-off and pre-departure preparation | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 3.2 Perform take-off roll | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 3.3 Perform transition to instrument flight rules | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 3.4 Perform initial climb to flap retraction altitude | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 3.5 Perform rejected take-off | S | S | S | S | S | R | S | N | S | S | R | R |
| ICAO | 3.6 Perform navigation | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 3.7 Manage abnormal and emergency situations | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.1 Perform standard instrument departure / en-route navigation | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.2 Complete climb procedures and checklists | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.3 Modify climb speeds, rate of climb and cruise altitude | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.4 Perform systems operation and procedure | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.5 Manage abnormal and emergency situations | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 4.6 Communicate with cabin crew, passengers and company | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.1 Monitor navigation accuracy | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.2 Monitor flight progress | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.3 Perform descent and approach planning | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.4 Perform systems operations and procedures | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.5 Manage abnormal and emergency situations | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 5.6 Communicate with cabin crew, passengers and company | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 6.1 Initiate and manage descent | S | S | N | S | S | R | S | N | S | S | R | R |
| ICAO | 6.2 Monitor and perform en route and descent navigation | S | S | N | S | S | R | N | N | S | S | R | N |
| ICAO | 6.3 Replanning and update of | S | S | N | S | S | R | S | N | S | S | R | R |

APPENDIX 10 – Examples of Airmanship (Source: ECA, 2013)

**What is Airmanship?**

- Effective flight planning
- Professionalism
  - motivation
  - mentoring
- Situational awareness
  - aware of available resources
  - environment
- Judgment
- Knowledge and transfer of knowledge into proper action
  - non-normal
  - know when not to act
  - think before acting
  - use of all means at the right time
  - apply competency in another context
- Awareness of Aircraft capabilities
  - performance
  - flight envelope
  - upset recovery
  - stalls
  - at all altitudes
- Awareness of pilot capability (define your own limits / margins)
- Retaining and adapting knowledge
- Self criticism/critic acceptance/self debriefing
- Decision making
  - when to say no
  - lateral thinking
- Stay ahead of Aircraft ➔ anticipation ➔ proactive actions
- Protect the available cognitive resources at all time
- Prioritize (aviate, navigate, communicate)
- Workload management
- Dealing with the unexpected
- Contingency planning (plan A,B,C....)
- Flexibility - adaptability
- Handling changing circumstances
- Know and respect procedures

Lack of Airmanship is already a recognized issue for pilots with significant flight experience.
Airmanship cannot be trained but educated by airmen and thus requires time to develop adequately.
Considering the present implementation status of MPL, and the massive transfer of training time to a virtual environment, ECA proposes to promote in particular the following areas to improve Airmanship of pilots, and especially of the MPL trainees:

- Situational awareness
- Judgment and decision making
- Assessment of own skill capability / aircraft capability