# MULTI CREW PILOT LICENCE

# HOW MANY HOURS OF FLIGHT TRAINING DOES IT TAKE TO BECOME AN AIRLINE PILOT?

By

Max F. Scheck

A Graduate Research Project
Submitted to the Extended Campus
In Partial Fulfillment of the Requirements of the Degree of
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This Graduate Research Project was prepared under the direction of the candidate's Research Committee Member, Herbert O. Hoffmann, Adjunct Associate Professor, Extended Campus, and the candidate's Research Committee Chair, Dr. Franz G. Rosenhammer, Associate Professor, Extended Campus, and has been approved by the Project Review Committee. It was submitted to the Extended Campus in partial fulfillment of the requirements for the degree of Master of Aeronautical Science.

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# ABSTRACT


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This study analyzed the Multi-Crew Pilot License (MPL), recently introduced by ICAO. The MPL concept per se, and potential flight-training hour requirements, which are not clearly defined and therefore cause some confusion were analyzed. The current literature and research was reviewed and, additionally, flight instructors were asked to give their assessments via a four-part survey. The author had three main hypotheses: (1) There is general consensus among flight instructors that current flight crew licensing and training procedures can be improved – (2) A significant portion (at least 50%) of the required flight training for the MPL can be conducted on synthetic flight training devices – (3) The initial flight training requirements for the MPL will require a significant number of flight training hours (at least 100) to be performed on an actual aircraft. The survey results supported hypotheses 1 and 3, but did not support hypothesis 2. The survey data also provided the basis for the development of a *base-line* flight hour requirement, for the MPL – with a total training-hour requirement of 258 to 280 training hours (with at least 144 training hours on actual aircraft). Finally, the author made several recommendations, including assessing critically the particular tasks encompassing the MPL and for all parties involved in the MPL development to cross-feed as much information as possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# CHAPTER I

# INTRODUCTION

What does it take to be an airline pilot? Does is take a seasoned individual, who has flown thousands of hours in all kinds of different aircraft, under all kinds of different flight conditions – or could a 20-year old individual, with as little as 60 hours of actual flight time, be a competent crew member at the controls of a B747?

In October 2001, the International Civil Aviation Organization (ICAO), through its Air Navigation Commission (ANC), established a Flight Crew Licensing and Training Panel (FCLTP) to take a closer look at the above question.

The main reasons why ICAO wanted to re-evaluate existing pilot training - and pilot-licensing procedures, were the evolution of the modern cockpit environment, as well as the advances in available training resources (i.e. training methodology and technology).

Additionally, the booming aviation markets in China and India will require a large number of airline pilots [ICAO (2006) estimated that from 2006 to 2012 an additional 140,000 First Officers will be needed worldwide]. Many experts feel that current flight training programs are not adequate to accommodate this growth, while ensuring a uniform training standard.

Over the past four years, the FCLTP has developed an alternative pilot-training concept, called Multi Crew Pilot License (MPL), specifically geared towards the training of airline pilots. The idea behind this novel concept was to focus the training on the actual skills required in a modern airline cockpit and to streamline training, by incorporating as much of the advances in educational science, training hardware (e.g. synthetic flight training devices) and information technology as possible.

A significant aspect of the MPL is that it is based on the Federal Aviation Administration's *Advanced Qualification Program* and that progression to the MPL follows the concept of *Competency Based Training*. This means that the MPL has to meet the same, or higher, standards as existing training programs; and training progression will be based upon trainees meeting certain skill and competency requirements.

Exactly how the MPL is to be benchmarked to existing flight training programs, however, continues to be heavily debated within the FCLTP. One area of controversy resulting from this context has been the question of how many hours of flight training, in particular how many hours of training in an actual aircraft (vs. a synthetic training device), should be established as the *base-line* for the MPL.

## Researcher's Work Setting and Role

The researcher is an airline pilot holding a JAR-FCL Airline Transport Pilot License, currently rated on the Boeing 747-400. He has more than 7500 flight hours, of which over 6000 have been on multi-engine jet aircraft.

He holds an undergraduate degree in Geography and English Studies from the University of Trier, Germany; and a Bachelor of Science in Professional Aeronautics from Embry Riddle Aeronautical University.

He is a member of the US Air Force Reserve. In this capacity, he has been a Paralegal for the Judge Advocate General's Corps for over 16 years, certified as a trainer for over seven years. He is also a member of the Air Reserve Component Paralegal Training and Utilization Review Committee – conducting reviews of existing training and utilization programs for the entire Judge Advocate General's Corps.

## Statement of the Problem

There are no existing benchmarks to determine how many hours of flight training, on actual aircraft and/or on synthetic flight training devices, are a reasonable basis for a *competency based* flight training program.

## Definition of Terms

### Ab-Initio Flight Training

The term *ab-initio,* is Latin and means *from the beginning.* In the context of flight training, ab-initio refers to training programs that focus on a professional career at an airline, versus merely giving flight instruction.

Ab-initio flight training emerged in Europe in the 1960s, and some US flight academies began to offer ab-initio programs in the 1980s. Typically, ab-initio flight training involves less actual flight hours, but a more structured and complex overall training program. (Phillips, 2005)

### Advanced Qualification Program (AQP)

The Advanced Qualification Program (AQP) is an initiative of the Federal Aviation Administration to allow US airlines to deviate from the traditional regulatory requirements under the Code of Federal Regulations (CFR) 14, Parts 121 and 135 for pilot training and checking. Airlines may volunteer to participate under the AQP. Alternate training concepts may be approved as long as the FAA is satisfied with the overall quality of the respective end-product. (Longridge, 2000)

### Airplane Simulator

(See Flight Simulator below)

## Commuter Airline

Commuter airlines are operators of small aircraft of a maximum size of 60 seats who perform at least five scheduled round trips per week between two or more points or carry mail. They operate under CAB Part 298, FAR 135, and at times FAR 121. (Kane, 1996)

## Competency Based Training (CBT)

Competency Based Training (CBT) is an education/training concept that is learner/participant centered and in which the unit of progression is mastery of specific knowledge and skills. This is in contrast to the "traditional" educational system, which is teacher centered and in which the unit of progression is time.

Two key terms used in CBT are:

***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.

(Sullivan, 1995)

## Complex Aircraft

A complex aircraft is one which has controllable pitch propeller, flaps, and retractable landing gear. (Jeppesen Sanderson, 1992)

## Crew Resource Management (CRM)

Crew Resource Management (CRM) has become somewhat of a buzzword in the aviation industry and basically refers to the management of all resources (i.e. people, information and equipment) available to the crew.

The term CRM began to appear in the literature in the 1980s (at the time, standing for *Cockpit* Resource Management), as a label for a new approach towards trying to optimize the management and utilization of available resources. As the research and work surrounding CRM continued over the years, the applicable working environment was expanded from the cockpit outward to include the cabin crew, controllers, maintainers and other personnel (hence *Crew* Resource Management). (Swezey & Andrews, 2001)

European Association of Airline Pilot Schools (EAAPS)

EAAPS is an association operating under Dutch law and originally consisted of:

- the Belgian Aviation School, Belgium
- Ecole de Pilotage Amaury de la Grange, France
- British Aerospace Flying College Limited, Great Britain,
- Deutsche Lufthansa AG Verkehrsfliegerschule, Germany
- KLM Luchtvaartschool BV, Netherlands
- SAS Flight Academy, Sweden.

The aims of EAAPS as stated in the “Articles of Association” are:

- to maintain and improve European standards for commercial airline pilot training
- to serve the interests of its members. (http://www.eaaps.org/, 16 Aug 2006)

European Civil Aviation Conference (ECAC)

ECAC was founded as an intergovernmental organization by the Conference on the Co-ordination of Air Transport in Europe at Strasbourg in 1955. In close liaison with ICAO and the Council of Europe, ECAC aims to promote the continued development of a safe, efficient and sustainable European air transport system.

ECAC uses ICAO Secretariat’s services. ECAC, however, adopts a work program and calls its own conferences and meetings. ECAC decisions are not binding by its member States. ECAC activities are only consultative in nature. Thus, any action taken by the Conference has to be transformed into national law and policies in order to take binding effect vis-à-vis third parties.

ECAC is composed of 38 Member States: Albania, Armenia, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Monaco, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, and Turkey. (http://www.airlaw-online.de/ecac.htm, 22 Nov 2005)

European Aviation Safety Agency (EASA)

EASA is an agency of the European Union which has been given specific regulatory and executive tasks in the field of aviation safety. It was formed in 2002, and is taking over much of the responsibilities of the Joint Aviation Authorities, and some of the responsibilities of the national Aviation Authorities, such as the United Kingdom Civil Aviation Authority. (http://en.wikipedia.org/wiki/Joint_Aviation_Authorities, 22 Nov 2005)

Fédération Aéronautique Internationale (FAI)

FAI is the world air sports federation, founded in 1905. It is a non-governmental and non-profit making international organisation with the basic aim of furthering aeronautical and astronautical activities worldwide. (http://www.fai.org/, 20 Nov 2005)

Federal Aviation Administration (FAA)

The Federal Aviation Administration (FAA), originally the Federal Aviation Agency, was established by the Federal Aviation Act of 1958 and became a component of the Department of Transportation in 1967 pursuant to the Department of Transportation Act. The

FAA is charged with regulating air commerce and operating a common system of air traffic control and navigation for all aircraft. (Kane, 1996)

## Fidelity

(See Simulation Fidelity below)

## Flag Carrier

The term flag carrier is a legacy of the time when most countries had a state owned airline. However, many of these airlines have been privatised and the airline industry deregulated, allowing multiple airlines to compete within each country's market. This has rendered the term less important than it was in the past. Today, the term is often used to refer to a transportation company (e.g. shipping or airline) that is registered in a given state. (http://en.wikipedia.org/wiki/Flag_carrier, 10 Oct 2006)

## Flight Simulator (a.k.a. Airplane Simulator)

A flight simulator is a realistic mechanical representation of an aircraft cockpit, which responds to the user's inputs in the same way as the aircraft itself. Additionally, a flight simulator is a realistic representation of an aircraft's behavior and an extremely sophisticated training device.

Depending on the level of sophistication, flight simulators are divided into four levels (A – D). Some of the more important components/characteristics of the respective levels include:

- *Level A* – system representations, switches, and controls which are required by the type; full-scale replication of the cockpit of the aircraft being simulated; correct simulation of the aerodynamic characteristics of the aircraft being simulated; at least a night visual system with at least a 45° horizontal by 30° vertical field of view for each pilot station; and a motion system for at least three degrees-of-freedom (DOF)

- *Level B* – as Level A, but additionally – correct simulation of the aerodynamic characteristics including ground effect, and ground dynamic characteristics of the aircraft being simulated

- *Level C* – as Level B, but additionally – at least a night and dusk visual system with at least a 75° horizontal by 30° vertical field of view for each pilot station and a motion system with at least six DOF

- *Level D* – as Level C, but additionally – a daylight, dusk, and night visual system with at least a 75° horizontal by 30° vertical field of view for each pilot station

(Moore 1999, 2002 & Rehmann, 1995)

## High-Performance Skill

A high-performance skill is defined as one for which (1) more than 100 hours of training are required, (2) substantial numbers of individuals fail to develop proficiency, and (3) the performance of the expert is qualitatively different from that of a novice.

(Schneider, 1985)

## Instructional Systems Development (ISD)

Instructional Systems Development (ISD) is an engineering approach towards development of training and performance standards. It has become a discipline of its own in aviation training and encompasses an iterative process from analysis to implementation of training and performance evaluation. (Teunissen, 2002).

## International Air Transport Association (IATA)

IATA was founded in Havana, Cuba, in April 1945. It is the economic association of commercial airlines and as such, the prime vehicle for inter-airline cooperation in promoting safe, reliable, secure and economical air services.

At its founding, IATA had 57 Members from 31 nations, mostly in Europe and North America. Today it has over 270 Members from more than 140 nations in every part of the globe. (Hall, 1989 & http://www.iata.org/about/history.htm, 20 Nov 2005)

International Business Aviation Council (IBAC)

IBAC is a non-profit, non-governmental association which represents, promotes and protects the interests of business aviation in international policy and regulatory venues. IBAC was founded on 15 June 1981; by-laws ratified on 14 September 1981.

Presently, IBAC encompasses 11 business aviation associations covering most of Western Europe, as well as the following countries: United States of America, Canada, Brazil, Southern Africa, Australia and Japan. (http://www.ibac.org/overview.htm, 20 Nov 2005)

International Council of Aircraft Owner and Pilot Associations (IAOPA)

IAOPA was founded in 1962 to provide a voice for general aviation and aerial work activities in the international aviation arena. Since that time it has been working with ICAO and regional aviation authorities to present and promote general aviation and aerial work needs and requirements. IAOPA represents the interests of affiliate organizations in 61 ICAO States, incorporating more than 470,000 pilots and aircraft operators. (http://www.iaopa.org/info/cns_atm.html, 20 Nov 2005-11-20)

International Federation of Airline Pilots Associations (IFALPA)

IFALPA was founded in 1948, with the overall mission to be the global voice of airline pilots, promoting the highest level of aviation safety world-wide and providing services, support and representation to all of its Member Associations.

Today IFALPA numbers over 90 Member Associations and represents in excess of 100,000 pilots. (http://www.ifalpa.org/, 22 Nov 2005)

International Federation of Helicopter Associations (IFHA)

IFHA encompasses various helicopter associations, including the Latin American Aviation Association (ALA), the European Helicopter Association (EHA), the Helicopter

Association of Southern Africa, the Rotary Wing Society of India, the Helicopter Association of Austral-Asia, the Helicopter Association of Canada and the Helicopter Association International.

IFHA membership includes helicopter operators and owners, users, manufacturers and suppliers, service organizations and individuals interested in following the events of the commercial helicopter industry. (http://www.rotor.com/regulations/IFHA/1.ppt, 22 Nov 2005)

## International Civil Aviation Organization (ICAO)

The International Civil Aviation Organization (ICAO) is a specialized agency of the United Nations whose mandate is to ensure the safe, efficient and orderly evolution of international civil aviation. ICAO was established in 1944, by the “Convention on International Civil Aviation” (a.k.a. the “Chicago Convention”).

The 96 articles of the Chicago Convention establish the privileges and restrictions of all contracting states and provide for the adoption of international standards and recommended practices. ICAO has its headquarters in Montreal, Canada, with seven regional offices throughout the world. Presently, there are 189 contracting states.

(Lufthansa, 1995 & ICAO, 20 Nov 2005)

## Joint Aviation Authority (JAA)

The Joint Aviation Authority (JAA) is the predominant regulatory body for aviation in Europe, representing the countries that have signed the ‘Arrangements Concerning the Development and the Acceptance of Joint Aviation Requirements’ (presently, 39 European countries are members of the JAA).

The JAA is responsible for the development and application of common provisions (so-called Joint Aviation Requirements - JARs) as well as of procedures concerning the safety and operation of aircraft. It develops and adopts JARs in the fields of aircraft design and manufacture, aircraft operations and maintenance, and the licensing of aviation personnel.

The objective of JAA is to provide high and consistent standards of safety, a "level playing-field" through harmonized and simplified regulations.

The JAA is associated with the European Civil Aviation Conference (ECAC) and roughly equivalent to the Federal Aviation Administration in the USA in that its primary concern is air safety, followed by the viability of the aviation industry. The JAA and FAA have a reciprocity agreement, meaning that each agrees to certify aircraft certified by the other agency.

The JAA is not part of, nor is it affiliated with, the European Union, although the JAA aims to eventually become part of the EU umbrella as a new European Aviation Safety Agency. (Jurish, 1998 & http://en.wikipedia.org/wiki/Joint_Aviation_Authorities)

## Joint Aviation Requirements (JARs)

The JARs are the common safety regulatory standards and procedures developed by the JAA. Generally, the JARs have to be transformed into national or EU law, as the JAA is, for the most part, only a co-operative body (vs. a regulatory authority). (http://www.airlaw-online.de/lr-jar.htm, 22 Nov 2005)

## Line Oriented Flight Training (LOFT)

Line Oriented Flight Training (LOFT) utilizes a flight simulator and a highly structured scenario to reflect a total line operational environment. It is a training activity in which errors are allowed to occur as they would do on a real flight. It is generally accepted as a better approach to training in that it emphasizes crew coordination in a realistic environment. (Hawkins, 1995 & Wood, 1997)

## Major Airline

Major airlines are ones earning revenues of $1 billion or more annually in scheduled service. All of the majors hold two certificates from the federal government, a fitness certificate and an operating certificate. (Kane, 1996)

## Motor Skills

Motor Skills (or Psycho-Motor Skills) are learned capabilities that underlie performances whose outcomes are reflected in the rapidity, accuracy, force, or smoothness of bodily movement and require coordinated muscular movements. (Gagne, 1985)

## Opportunity Cost

Opportunity Cost is defined as: That which we give up, or forgo, when we make a choice or a decision. (Case & Fair, 1999)

## Recommended Practices

Under ICAO, a Recommended Practice is any specification for physical characteristics, configuration, material, performance, personnel or procedure the uniform application of which is recognized as **desirable in the interest of safety, uniformity or efficiency** of international air navigation, and to which **Contracting States will endeavor to conform** in accordance with the Chicago Convention. States are **invited to inform the Council of non-compliance**. (Lufthansa, 1995 & ICAO, 2005)

## Regional Airline

As their name implies, regional carriers are airlines whose service for the most part is limited to a single region of the country, transporting travelers between the major cities of their region and smaller, surrounding communities. Regional carriers are divided into three subgroups: large, medium and small. (Kane, 1996)

## Simulation

A faithful simulation requires three elements:

1 – A complete model, preferably expressed mathematically, of the response of the simulated entity (e.g. aircraft) to all its inputs, both from the operator and the environment

2 – A means of solving these equations in real time

3 – A means of presenting the output of this solution to the operator by means of mechanical, visual and aural responses (Moore, 1999)

## Simulation Fidelity

Simulation Fidelity is the degree of similarity between the training situation and the operational situation, which is simulated. It is a two dimensional measurement of this similarity in terms of (a) the physical characteristics, for example, visual, spatial, kinesthetic, etc.; and (2) the functional characteristics, for example, the informational, and stimulus response options of the training situation. (Lee, 2002)

## Standard

Under ICAO, a Standard is any specification for physical characteristics, configuration, material, performance, personnel or procedure, the uniform application of which is recognized as **necessary for the safety or regularity** of international air navigation, and to which **Contracting States will conform** in accordance with the Convention; **in the event of impossibility of compliance, notification of the Council is compulsory** under Article 38 of the Chicago Convention. (Lufthansa, 1995 & ICAO, 2005)

## Synthetic Flight Training Device (SFTD)

A synthetic flight training device (SFTD) is any device that simulates an aircraft, an aircraft system, flight or any portion of flight. A SFTD may be as simple as a mere two-dimensional graphical representation of a cockpit layout (i.e. a "cockpit poster") – or as complex as a Level D full flight simulator.

For the purpose of this study, the different types of SFTDs are:

- **Type I** - E-training and part tasking devices

- **Type II** – Simulation of generic turbine powered aeroplane

- **Type III** – Simulation of multi-engine turbine powered aeroplane with the following features:

    -- Certificated for 2 pilots
    -- Enhanced daylight visual system
    -- Autopilot, allowing progressive introduction of sophisticated flight environment

- **Type IV** – Fully equivalent to Level D Full Flight Simulator

## Threat Error Management (TEM)

Threat Error Management (TEM) is an overarching safety concept that recognizes the influence of threatening outside factors on human performance in the dynamic work environment. Examples of threats could be adverse weather conditions, stressful ATC activities, airport problems, terrain and traffic awareness, errors in aircraft handling and ground navigation, technical problems and incorrect aircraft configurations. (Sutton, 2005)

## Transfer of Training

Transfer of training is the way in which previous learning affects new learning or performance. In other words which elements of prior training [e.g. learned skills, impressions (conscious- and/or subconscious), acquired knowledge, etc.] transfer to future situations; both, new training- and/or real-life situations. (Swezey & Andrews, 2001)

## Limitations and Assumptions

This report is limited to the initial analysis of required flight hours for the MPL to determine a *base-line* flight hour requirement.  This base-line may then be used as a sort of starting-point from which to begin the iterative process of determining appropriate number of flight hours in a CBT program.

This report does not analyze potential performance standards for competency analysis, nor does it cover potential evaluation criteria for such standards.

This report gives only a brief review of the potential advantages and disadvantages of the MPL and does not analyze these in detail.

It is assumed that there are flight schools and flight training academies that have a vested interest in offering a MPL training program.

# CHAPTER II

# REVIEW OF RLEVANT LITERATURE AND RESEARCH

## Multi Crew Pilot License – A New Concept

As mentioned in the introduction, ICAO began to take a serious look at an alternative approach towards airline pilot training and licensing in 2001. It was, in fact, the first major review of this kind in over 25 years – and before then, there had only been minimal changes to the flight time requirements that had been formulated in 1944.

There were several reasons why ICAO decided to look into its existing pilot training and licensing practices – in particular, the use of synthetic flight training devices (SFTDs) in pilot training. In his article "The Future of Simulation and Training" (Teunisson, 1999), Captain Teunisson of the KLM Dutch Airlines Flight Training Center identified five dominating forces in this context:

(1) **Air Transport Safety Concerns** – increased use of synthetic flight training devices improves the overall safety in air transportation in several ways

   a. Hazardous training maneuvers (e.g. stalls, engine failures) can be practiced without "real" dangers.

   b. A more "controlled" training environment allows for better training, resulting in better pilots with fewer accidents/incidents.

(2) **Environmental Concerns –** moving training from the air to a synthetic flight training device reduces fuel consumption, air- and noise pollution.

(3) **Competition –** cost and quality are constant concerns of airline managers; synthetic flight training devices are, generally, a lot cheaper to operate than actual aircraft; some training tasks can be taught on extremely rudimentary training devices (e.g. Type I), with the same, or greater, transfer of training; by using SFTD, actual aircraft do not have to be taken out of regular service for training purposes

(4) **Flexibility –** reduced throughput times of pilot training and less training requirements on actual aircraft increase the operational flexibility of airlines, enabling managers to react more flexibly to market fluctuations.

(5) **Regulations –** in the wake of globalization, increased harmonization of licensing and training requirements is required to ensure a "level playing field" and consistent safety standards throughout the world.

The above five forces call for more effective and efficient alternatives to the existing pilot licensing and training standards. Before continuing with an analysis of a potential alternative training proposal, a brief review of the organizational structure of ICAO, as well as how ICAO creates international standards was appropriate. This information was retrieved directly from the ICAO website (ICAO, 20 Nov 2005).

Creation of International Standards through ICAO

ICAO is made up of an *Assembl*y, a *Council* and a *Secretaria*t. The Assembly is the sovereign body of ICAO and is composed of representatives of all Contracting States. The Assembly meets every three years to elect the Council, which is the governing body of ICAO for a three-year term.

The Council is composed of members from 36 states and formulates the various types of standards and other provisions. The four main types of these standards and provisions are:

(1) – Standards and Recommended Practices (SARPS)

(2) – Procedures for Air Navigation Services (PANS)

(3) – Regional Supplementary Procedures (SUPPs)

(4) – Guidance Material

The SARPS are the most important type of provision, and they are included in the 18 Annexes to the Chicago Convention. To facilitate the development of the 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, or ICAO itself, may submit a proposal for a new or revised SARP. Proposals concerning a technical SARP are first analyzed by the ANC. The ANC is composed of fifteen experts with appropriate qualifications and experience in various fields of aviation. The members are nominated by Contracting States and appointed by the Council.

Depending on the complexity of the proposal, a specialized working group may be assigned by the ANC to facilitate the review process.

One type of such a specialized working group is an ANC *panel*. ANC panels are composed of qualified experts to advance, within specified time frames, the solution of specialized 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 new SARPS. The ANC, in-turn, 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 (i.e. PANS, SUPPs or guidance material). A two-third majority of the Council members is required for an amendment to the Annexes.

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 the Contracting States indicates disapproval, the amendment will become effective and the Contracting States assume the responsibility of implementing the change(s) accordingly.

If a State elects not to implement the amendment(s), the state is required to submit a written *Notification of Differences* on all Standards and is invited to submit such a notification on all Recommended Practices. (Figure 1 is a graphical presentation of the entire process of a SARP proposal.)

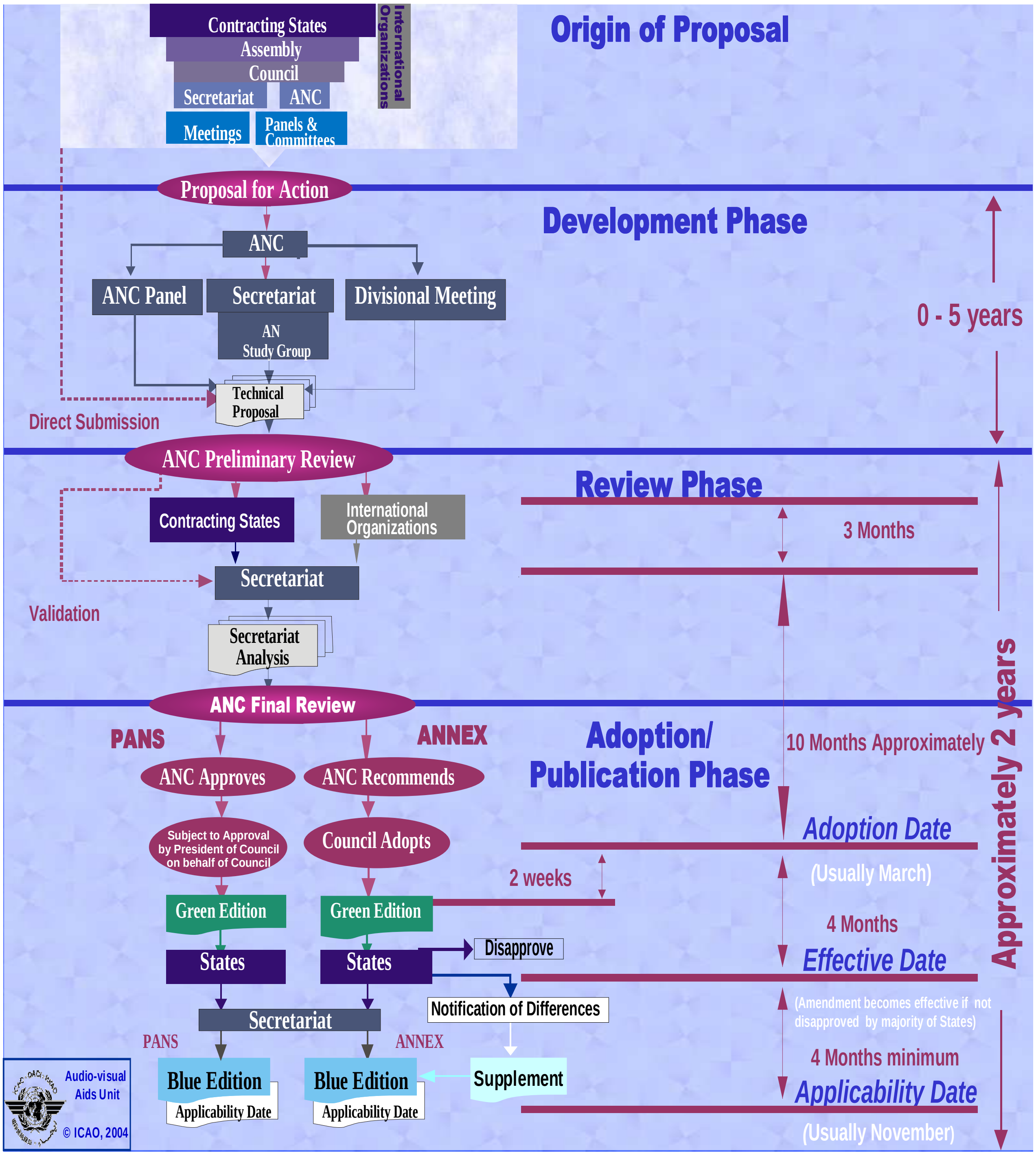


Figure 1. Development of SARPs. From ICAO. Making an ICAO Standard. Timeline. http://www.icao.int/icao/en/anb/images/timeline.jpg 20 Nov 2005

After this brief review of ICAO and how it develops international standards, the author was able to analyze the proposed amendment to pilot training and licensing.

Proposed Amendment to Pilot Training and Licensing

The initial request for a review of existing pilot training and licensing requirements originated from Germany 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 (the author will address ab-initio flight training later in this chapter) and some of the German airline flight training managers felt that the existing flight training standards were outdated.

The ANC of ICAO saw enough potential merit [see also the five forces mentioned at the beginning of this chapter (i.e. safety, environment, economy, flexibility and regulations)] in the request to establish a Flight Crew Licensing and Training Panel (FCLTP) in October 2001. The main objective of the FCLTP was to review the existing flight crew licensing and training standards – the first such review in 26 years.

A comprehensive summary of the FCLTP can be found in a *Power-Point* presentation by G. Forbes (2004) of the Civil Aviation Authority of the United Kingdom. The following are some of the main points of this presentation.

The members of the FCLTP are representatives from several countries (Australia, Brazil, Canada, China, Egypt, France, Germany, Japan, Netherlands, Russian Federation, Singapore, South Africa, United Kingdom and United States) as well as from various organizations (IAOPA, IATA, IBAC and IFALPA). There were also some observers from the following countries/organizations present during the FCLTP proceedings (Korea, New Zealand, FAI, JAA and IFHA).

According to Forbes, some of the areas that were addressed by the FCLTP were:

- The need to update standards to reflect developments in aircraft operations, training methodologies and technology
- The need to develop an alternate flight crew licensing and training program (to complement existing licences), based on a Competency Based Training (CBT) philosophy, rather than traditional training philosophies, to account for the wide range of cultures and capabilities in the world today
- The need to account for the availability of new, increasingly sophisticated, synthetic training equipment; and how training on such equipment could be credited during pilot training

The members of the FCLTP agreed that some adjustments to current flight crew licensing and training standards had to be made to account for the fact that modern airline cockpits and airline flight operations have become increasingly automated. This increased automation has resulted in a shift of the required piloting skills from mainly manual *flight skills* to cognitive *system operator skills* – and pilot training should reflect this.

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 advances in training methodology (e.g. CBT, ISD), training equipment (i.e. SFTDs) and information technology (e.g. computers, internet).

Between 2001 and 2005, the FCLTP tried to work the above into actual proposals and/or amendments. According to Forbes this resulted in the following:

- Amendments to Standards and Recommended Practices (SARPS):
    - Annex I Flight Crew Licence Requirements
    - Annex 6 Part I & Part III Training Requirements Recommendations for certification/approval of Training Organisations

- Approval of Training Organisations with regards to the areas mentioned above

- Development of proposals for a Multi-Crew Pilot Licence (MPL) – Aeroplane

The MPL was, perhaps, the most significant aspect of the FCLTP proposals and is the main focus of this study. Forbes summarized the broad principles of the MPL as follows:

- MPL is an additional license (not a substitute to existing requirements)
- Licence focused on ab-initio airline pilot training
- Competency based training & assessment
- Greater emphasis on SFTDs
- Training based in multi-crew environment
- Emphasis on Crew Resource Management (CRM)
- Threat and Error Management (TEM)
- Medical Standards same as existing licences
- Core flying skills including mandatory upset training

Upon completion of the MPL, the student pilot should possess the following core competencies:

- Apply TEM
- Perform Aeroplane ground operations
- Perform Take-off
- Perform Climb
- Perform Cruise
- Perform Descent
- Perform Approach
- Perform Landing
- Perform after-landing and aeroplane post-flight operations

Exactly how the above core competencies should be trained (in terms of actual training hours on aircraft and/or SFTDs), what the exact parameters to determine satisfactory performance for the respective competencies should be, and how to measure these parameters, continues to be heavily debated within the FCLTP.

The FCLTP did agree on a minimum of 240 flight hours; however, how many of these hours have to be on actual aircraft versus SFTDs was not specified. Those FCLTP-members who come from a managerial background advocate a MPL with very few actual flight hours (60 or less – potentially down to a *zero flight hour* program) – while the FCLTP-members from operational backgrounds (e.g. pilots or pilot organizations) insist a certain number of flight hours (120 or more) have to be performed on actual aircraft.

The FCLTP literally "passed the buck", by leaving it up to the Approved Training Organizations (ATOs) to determine the breakdown of flight hours. The FCLTP saw no potential problems there, as a major element of the MPL is CBT; thus, no student should hold a MPL unless she or he has satisfactorily completed the required core tasks.

The following are excerpts from the FCLTP's guidelines for the implementation of the MPL [Harter (2005), p.26]:

"*…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 simulator…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 essence, the MPL is an alternative avenue for certain ATOs to explore ways to streamline and/or improve ab-initio training for airline co-pilots. As such, the MPL is very much along the lines of the FAA's Advanced Qualification Program (AQP), which allows for deviations from traditional regulatory requirements as long as the overall quality of the respective end-product (→ in the case of the MPL an airline co-pilot) is assured.

The FCLTP did give some additional guidance on the proposed MPL, in particular on how the training hours should be divided between different levels of training. Forbes summarized this in the following figure:

INTEGRATED THEORETICAL KNOWLEDGE

| Developmental MPL Training Schedule – 240 hours | | |
|---|---|---|
| DEVICE | HOURS | PHASE |
| Aeroplane Type IV SFTD | Aircraft Type Training | Level 3<br>Advanced Level of Competency<br>(Including Proof of Competence Check and Aeroplane Training) |
| Type IV SFTD | Proof of Competence | |
| Type IV SFTD | 30 PF/30 PNF | |
| Type III - IV SFTD | 30 PF/30 PNF | Level 2<br>Intermediate Level Competency |
| Type II – III SFTD | 30 PF/30 PNF | Level 1<br>Basic Level of Competency |
| Aeroplane<br>Type I – II SFTD | Minimum of 60 (option for higher hours) | Core Flying Skills<br>(Including upset training, night flying and instrument appreciation)<br>PPL Flight Training |
| Core Flying Skills can be integrated with Basic Level | | |

Civil Aviation Authority

CRM & TEM

8 November 2004 Slide 13

Figure 2. Developmental MPL Training Schedule. From *ICAO's Multi-Crew Pilots Licence - a New Licence in Development* European Aviation Training Symposium, Forbes G., 8 November 2004, Slide 13.

One of the biggest challenges surrounding the MPL will be to formulate the exact skills and competencies required to qualify as a “fully operational” airline co-pilot and to figure out ways to measure these skills and competencies in an objective and consistent manner.

However, before the skills, competencies and ways to measure these can even be addressed, a more basic problem has to be looked at.

The current pilot training and licensing practices are based upon the “traditional” approach, where *time* (i.e. flight hours) is the unit of progression for pilots on their way to become airline pilots. CBT, where the unit of progression is no longer time, but the mastery of specific skills and competencies, is a novel approach in flight training.

To shift from the traditional approach to a CBT approach, some reference *base-line* is needed from which to start the iterative process of determining where time (i.e. flight hours) can be substituted by whatever skills and competencies are identified.

In the context of the MPL, this base-line is the initial number of flight hours in the actual aircraft versus a synthetic flight training device (SFTD), from which the ATO starts to train MPL students. This number is then adjusted as the MPL program progresses and exact requirements crystallize.

Where should the ATO start – at 60 hours as propagated by the managers - at the 120 hours pilots favour - or at a totally different number?

The author believed a good approach to determining this base-line was to survey experienced flight instructors on how many hours they feel a student pilot typically needs to learn the core competencies identified for the MPL. The author holds that, absent any first-hand knowledge (i.e. actual MPL training experience), flight instructors provide the next best source of expertise to determine the base-line requirements.

As the MPL has initially been restricted to ATOs with experience in ab-initio (or equivalent) programs, the survey concentrated on flight instructors who have had experience with ab-initio flight training. To understand the importance of this, the ab-initio flight training concept had to be reviewed.

## Ab-Initio Flight Training

A very good summary on ab-initio flight training can be found on the AOPA website (Phillips, 2005). Ab-initio (Latin for *from the beginning*) flight training is a concept that sees the student pilot through from zero flight hours to a Commercial Pilot License in one continuous training program.

The concept emerged in the 1960s in Western Europe, where many airlines operated their own pilot academies (e.g. Air France, SwissAir, KLM, British Airways, Lufthansa). The idea behind the ab-initio pilot training was that airlines could pick student pilots according to a certain psychological and physiological profile at an early age and then "groom" these students specifically for a piloting career with the respective airline.

The ab-initio student pilots completed the legal minimum (or slightly more) required flight hours (about 240 for a Commercial Pilots License), but every training hour focused on the future job of being an airline pilot. In general, many of the training hours were taught on complex aircraft or Type IV SFTDs.

Typically, ab-initio training is highly standardized, resulting in very homogeneous graduate co-pilots. These co-pilots can immediately transfer into airline type rating and line transition training – in fact, this phase of training builds on the foundation laid during the ab-initio program.

The high degrees of standardization and homogeneity greatly enhance all phases of training – from the ab-initio training through airline type-rating and transition – which greatly improves the overall effectiveness and efficiency of the entire training.

Often, the airlines paid for some, or all, of the training in exchange for a long-term commitment by the students to fly for the respective airline. The airlines felt that this initial investment more than paid off in the long run, as it improved the overall quality and corporate identity of its pilots.

An additional factor for the inception of ab-initio training was the fact that in Europe the pool of available qualified pilots was not nearly as big as in, for example, the US where a large military provided a constant supply of qualified pilots.

In the US, ab-initio flight training has been a fairly recent development (starting in the early 1990s) – and there are several significant differences. These differences are largely attributable to significantly different overall training and licensing philosophies between Western Europe and the US.

## Differences in US versus Western European Flight Training Philosophies

Traditionally, the way to get into the cockpit of a major US airline has been to accumulate several thousand hours of flight time, with at least several hundred hours on multi-engine aircraft.

Basically, there were two avenues to log these hours – (1) through the military; or (2) start off with a Private Pilot License, then get a Commercial Pilot License, then a Flight Instructor Rating to build hours to upgrade to an IFR- and Multi-Engine Rating to be able to get a job with some Commuter Airline to accrue the necessary multi-engine hours until, finally, enough hours have been accumulated to qualify for a job with a Major Airline.

Either career path, military or civilian, took many years; the civilian avenue also could cost a significant sum of money along the way.

In Europe, the above career-paths (i.e. military and step-by-step civilian training) have also been available for pilots. However, there has been an additional career-path - training through a pilot academy run by one of the major airlines. The reason for this additional career-path is mainly historical, since a lot of the major European airlines began operating as so-called *flag-carriers*. As these airlines were operated by the respective government under which flag the aircraft were registered, most of the employees of these airlines (including the aircrew) were state-employees. Similar to the military, where the government conducts and pays for the training of its pilots, state-owned airlines often operated their own training facilities and paid for the training of their pilots as well.

In the wake of deregulation several of the flag-carriers became fully privatized (e.g. KLM, British Airways, Swissair or Lufthansa). Other countries, such as France or Italy, semi-privatized their respective flag-carriers (here: Air France and Alitalia) by converting the airline into a corporation with the respective government maintaining a majority in shares.

As the flag-carriers privatized, the status of its pilots changed from state-employees to "regular" employees and several of the airlines stopped paying for the training of its pilots. Some of the training academies, which previously had been part of the state-operated airline, were also privatized and began to offer training for anyone who was willing to pay. Examples of this are the Lufthansa Flight Training Academy in Bremen, Germany - the Scandinavian Airlines (SAS) Academy in Stockholm, Sweden – or the KLM Academy in Amsterdam in the Netherlands.

As mentioned in the previous chapter, ab-initio training programs were developed at the European flight training academies, as the pool of qualified pilots was much smaller in Europe compared to the US (→ mainly due to the large US military).

As the US military significantly cut its forces after the demise of the Warsaw Pact in the early 1990s, the number of military pilots went down accordingly. At some point, this resulted in a shortage of qualified pilots in the US. This was the time that the first ab-initio flight training programs began to appear in the US.

The US ab-initio programs, however, differ from most Western European programs in that the US programs are generally geared towards preparing students for a position with a Regional or Commuter Airline first (vs. Europe, where the ab-initio programs typically train the students for a job directly with a Major Airline). Additionally, ab-initio programs in the US are normally not directly run by an airline, but by a separate institution (often a university or college).

In the US, the cost of the ab-initio training is also, normally, not paid for by the airline. Instead, the student assumes the financial risk, but gets job placement assistance from the respective training institution. Often, the training institution has affiliate airlines involved in the ab-initio program. These airlines often look at the ab-initio graduates first to fill any job positions. As pointed out in the previous chapter, European airlines often paid for the training of their pilots and, to some degree, continue to do so today.

The fact that in the US ab-initio programs are not run directly by a particular airline has resulted in a wider spectrum of different programs and in the US-programs being somewhat more generic than programs in Western Europe.

According to Phillips (2005) some of the more notable ab-initio programs in the US (affiliate airline in parentheses) include the Comair Academy in Sanford, Florida (Comair); San Juan College in Farmington, New Mexico (Mesa Air Group); the University of Nebraska-Omaha (Great Lakes Airlines and ATA Connection); the University of North Dakota (no direct affiliate airline, but job placement assistance) and Embry-Riddle Aeronautical University (Atlantic Coast Airlines).

Another reason for the differences in ab-initio programs between Western Europe and the US has been the different pilot licensing and pilot training systems.

NOTE: For analysis of licensing and training systems, the author has used the JAA as representative of Western Europe. Most Western European countries are now part of the JAA and further distinctions within European countries would have exceeded the scope of this study.

Differences between US and Western European Pilot Licensing and Training Requirements

The Licensing Workshop of the 20th JAA/FAA International Conference (Woods and White, 2003) published a short paper on "General Philosophies behind FAA and JAA Pilot Licensing and Pilot Training Systems". The paper highlights some of the major differences between the JAA and the FAA:

With regard to licensing -

- The JAA, via the provisions of the *JAR-Flight Crew Licensing* Part 1 (*Flight Crew Licensing Airplane*), provides for two training systems for acquiring license(s) and rating(s)
    - (1) – Integrated training programs, where the programs aim to train ab-initio
    - (2) – Step-by-Step, modular training programs, where the programs aim to train existing license holders on modular courses
- In the US, the FAA only provides for the modular approach to pilot certification (i.e. each level of pilot certificate builds upon the knowledge and experience gained at the previous level); the FAA system emphasizes practical testing and certificates/ratings may be acquired in three ways
    - (1) – through an individual training program with an FAA certificated flight instructor
    - (2) through an FAA approved training curriculum at an FAA pilot school or training center (see below)

- (3) through an FAA approved air carrier training program and required checking under 14 Code of Federal Regulations (CFR) part 121 or part 135

With regards to pilot training organizations –

- Under the JAA system there are three types of approved pilot training organizations
  - (1) - Flight Training Organization; which train individuals for the Private-, Commercial- or Air Transport Pilot Licence
  - (2) - Type Rating Training Organization; which provides type rating, and/or Multi-Crew Co-Operation training, and/or synthetic flight instruction to pilots already holding a license
  - (3) – Facilities, or sub-contracted facilities, provided by an operator or a manufacturer – which provide Type and Class rating training to pilots already holding a license
- Under the FAA system there are two types of approved pilot training organizations
  - (1) – Pilot Schools under 14 CFR Part 141 – provide training for pilot certificates, ratings and type ratings – principally using aircraft in its training
  - (2) – Training Centers under 14 CFR Part 142 – provide training for pilot certificates, ratings and type ratings – principally using SFTDs in its training

The author believes that the short review of the ab-initio concept and some of the differences in licensing and training philosophies between Western Europe and the US helps in understanding some of the issues surrounding the MPL.

The MPL, in essence, is an advancement of the ab-initio concept. Ab-initio programs provide for an alternate path to receive certain licenses/ratings, while the MPL is a license of its own.

The MPL stresses integrated training even more than ab-initio programs do and the MPL introduces CBT as a novel way to assess proficiency. Under CBT, skills and competencies become the unit of progression – versus flight time under the "traditional" systems (including ab-initio).

It is not surprising that the initial proposal for the MPL came from Europe, as ab-initio training has a much longer history there. Additionally, the existing licensing and training philosophies, as well as the legal framework in Europe (i.e. JAA) are much more conducive to the proposed MPL.

The author thinks it is vital to consider the above when trying to determine the base-line flight hour requirements for the MPL. The flight instructors to be surveyed for the base-line requirements should have, at least, a working knowledge of the ab-initio concept.

The final areas, in which the author felt a review of the existing literature was required, were the areas of *training* and *simulation*. As mentioned in the Limitations, an in-depth review of these areas would have exceeded the scope of this study; however, some basic concepts had to be looked at.

## Training

P. Caro (1988) formulated a good working definition for training: "*Training is the systematic modification of behaviour through instruction, practice, measurement, and feedback.*"

A very comprehensive review of training in the context of simulation can be found in Swezey and Andrews (ed) (2001). In a series of articles this book traces the most significant developments and insights into training and simulation of the past 30 years.

In the first article Blaiwes, Puig and Regan (Swezey and Andrews, 2001 pp. 2 – 12) address the issue of *Transfer of Training*, in particular with regard to measurement of training effectiveness and efficiency.

*Training Effectiveness* refers to the degree to which the training objectives are being met by the respective training program. This has to be distinguished from training *efficiency*, which refers to the overall *opportunity cost* (e.g. financial cost, time requirements, chance of failure) of the training program.

The ultimate goal of any type of training is to enable the trainee to apply whatever knowledge and skills are acquired through the training to real-life situations. The degree, to which this potential to *transfer* training knowledge into real-world applications is achieved, is referred to as *transfer of training*.

Some training can be conducted directly on-the-job, or in an environment which exactly duplicates the real world. Either setting places the trainee in a real-life training environment. However, there are several reasons why such a real life environment for training is not always possible – or desirable.

Blaiwes et al give four main reasons for deviations from a real-life training environment:

(1) **Training-Effectiveness –** for some training task(s) it is contrary to good training practice to try to make an exact replica of certain real jobs

(2) **Training-Efficiency –** often training equipment is much cheaper than the "real" equipment and trainees can "play around" with the training equipment without running the risk of hampering actual operations

(3) **Safety** – the real-life job(s) may be too dangerous for a novice trainee – by removing some or all of the dangers, trainees can learn before they are exposed to actual danger

(4) **Technological Barriers** – technological and other reasons make it impossible (or impractical) to duplicate the real-life environment

Experience has shown that training effectiveness and efficiency are often enhanced by deviating from the real-life environment. In particular high performance tasks are more easily learned when broken down into several, smaller and less complex, part-tasks.

On the other hand, any deviation from the real-life environment carries the risk of not conveying sufficiently, or adequately, the required knowledge and skills – i.e. not yielding the desired transfer of training.

An obvious problem, thus, is to determine how much the training environment *may deviate* from the real-life environment, *while maintaining the desired transfer of training* – or how much the training environment *should deviate to improve the transfer of training*.

Another, more basic, problem is how to assess - or *measure* - transfer of training. In other words, how can training managers measure the transfer achieved by one training program versus the transfer achieved by another.

Both of the above problems continue to be heavily debated among scholars and practitioners within the training industry. The problems are closely related to the problems of evaluation-criteria and performance-based-training mentioned throughout this study and, thus, are also at the core of some of the issues surrounding the MPL.

While there is not one satisfactory answer to the above problems, there have been a few attempts on determining how to measure transfer of training, in particular, measuring the impact of substituting portions of an existing training program by alternate training methods/ devices (e.g. synthetic training devices).

Perhaps, the most basic such comparison is looking at the *percent transfer* (PT). Here simply the amount of a particular training before and after a change in training procedures/equipment is looked at, without consideration of the substitution per se.

$$\mathbf{PT = T_s/T_{t0}}$$

(PT = Percent Transfer, $T_{t0}$ = Total Time before alternate training, $T_s$ = Time Saved)

For example: If the use of a Type I SFTD results in the reduction of required flight hours on the actual aircraft from 25 to 20 hours, the PT is 20%. The PT does not take into account how many hours of alternative training (in our example, how many hours on the Type I SFTD) are required to achieve this.

Blaiwes et al mention a more refined method of measurement – the *transfer effectiveness ratio* (TER). The TER does account for the "alternative training time" required to achieve an improvement in transfer; the formula for TER is:

$$\mathbf{TER = (T_{t0} - T_{t1}) / T_a}$$

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

In the prior example, if $T_a$ were 5 hours, the TER would be 1.00 – if $T_a$ were 10 hours, TER would be 0.50.

Obviously, the higher the TER, the more effective the alternate training time in terms of total time saved. A negative TER is possible and would imply that the alternate training resulted in more total training time than before the alternative was introduced.

Negative TERs are typically the result of inadequate or faulty simulations. For example, if a flight student learns to fly on a SFTD which does not correctly simulate the flight characteristics of the actual aircraft, the trainee 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 student had learned the skills directly in the aircraft in the first place – the net-result would then be a negative TER.

TER is only one parameter to consider when evaluating training alternatives for effectiveness and efficiency. Safety is another important consideration - a lengthier training program may be preferable over a short but inherently dangerous alternative.

Ultimately, effectiveness will determine which training alternatives should be used. A Type I SFTD may cost a few dollars an hour versus a Type IV SFTD, which can easily cost several thousand dollars an hour – under these circumstances, use of the Type I device could still be worthwhile even if the TER of its use would be as low as 0.01 (see also Subchapter "Substitution of Flight Hours by Simulation", pp. 44 - 48 below)

Another, perhaps more crucial, aspect surrounding evaluation of training effectiveness and efficiency is *retention*. In other words, not only quality training is important, but also how long the trainee will maintain the acquired knowledge and skills.

Swezey & Andrews list three variables influencing retention (p. 72):

(1) degree of original learning

(2) characteristics of the learning task

(3) instructional methods and strategies used during training

Swezey and Andrews hold that the most important of these variables is the extent of original learning. They found that the greater the degree of 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.

There is, however, a point at which the degree of learning may become too high – "overloading" the trainee. Also, training program managers have to ensure that the trainees learn skills and knowledge required for the job – versus skills and knowledge required to pass examinations.

Other potential problems surrounding training programs are addressed by Schneider (1985) in his article: "Training High-Performance Skills: Fallacies and Guidelines". Schneider came to the conclusion that there are special problems associated with the training of high-performance skills (→ airline flight operations are such a skill). He continues that training programs can only be optimized if the training-program designers have an in-depth understanding of the complexities involved and are able to give due consideration to potential problems.

The training industry has responded to the above by developing systematic approaches towards training. One such approach is the *Instructional Systems Development* (ISD, also known as *Systems Approach to Training*.

ISD emerged in the 1960s, but really began to be incorporated into training development in the 1980s. In particular, the US military used ISD in its training design, and there is an abundance of information on ISD available on-line through various military websites (e.g. http://www.au.af.mil/au/awc/awcgate/doe/isd/paper.htm, 24 Nov 2005).

The basic concept of ISD is very generic and, consequently, there have been many different ways to apply this concept. For the purpose of this study, a review of the basic concept was sufficient.

ISD breaks training development down into five, interrelated phases – (1) Analysis (2) Design (3) Development (4) Implementation and (5) Evaluation (see Figure 3 below).

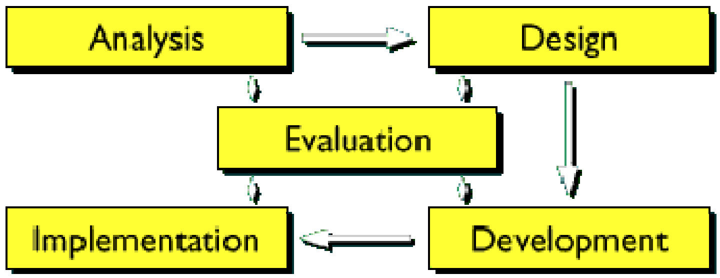


Figure 3. The Phases of the Instructional Systems Development (ISD) Model.
From: INSTRUCTIONAL SYSTEMS DEVELOPMENT (ISD)
http://www.au.af.mil/au/awc/awcgate/doe/isd/paper.htm

The five phases assist the training designer in determining whether instruction is necessary in the first place - if so, in determining what instruction is required – and in developing the appropriate training materials (e.g. training curricula, instructional methods and media to be used).

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. Also, ISD is a truly iterative approach – i.e. the various phases built on each other and the process is never complete, but a constant repetitive loop to ensure optimization of the training program.

The above relates to how Blaiwes et al summed up optimization of training programs. They view training optimization as a continuous process, involving complex experimentation to determine the best mixture- and sequence of academic training, on-the-job training and simulator time.

The increased emphasis on simulator time in the MPL training concept made a brief review of simulation in flight training necessary.

## Simulation

There are many definitions of simulation and the author refers the reader to Hays and Singer (1989), or McGuire et al (1975), for a more in-depth review of some of the definitions. The author chose the definition given at the beginning of this paper (see *Definition of Terms*), as that definition is one of the more basic, covering the main elements.

For the purpose of this chapter, it is more important to understand the *purpose of simulation*. According to Allessi and Trollip (1991), simulations help students *build a useful mental model* of a part (or parts) of the world, and provide an *opportunity to test this mental model safely and efficiently*.

Allessi and Trollip divide simulations into two main groups:

(1) ***Teach About* group –** subdivided into *Physical* and *Process* simulations

(2) ***How To Do* group –** subdivided into *Procedural* and *Situational* simulations

Hays and Singer point out that it is also important to distinguish between *simulation* and *simulator* – the latter being the media through which a trainee may experience a simulation.

In the above sense, simulations and simulators, in one shape or another, are probably as old as training itself. Many strategy games (e.g. chess) are, in a way, a simulation. Also, mock-ups of real-life equipment (→ simulators) have been used for hundreds of years (e.g. the jousting trainers used by medieval knights).

Simulations allow removal of the training from real-life hazards and are often very inexpensive to realize. Additionally, simulations provide for a more controlled training environment, as unwanted elements or distractions can be left out of the simulation. This allows for a more focused training, concentrating on a particular task – or tasks.

The more complex the overall training objectives, the greater the potential benefits of simulations. Thus, simulations can enhance the training of high performance skills (e.g. flying) immensely. Consequently, simulations were used virtually from the beginning of powered flight.

The first *flight simulators* became available around 1910, and by the late 1920s Edward Link had already developed fairly sophisticated flight simulators. These *Link Trainers* were able to produce a “motion sensation” [with three degrees of freedom – pitch, roll and yaw] by balancing the training device on compressed air actuators. Overall, however, these first flight simulators were still rather rudimentary – and the prime purpose of these simulators was procedure training rather than flight training.

Vast improvements in control engineering, integrated circuits, computer processing, and image generation enabled engineers to develop much more sophisticated flight simulators. Hydraulic actuators allow for six degrees of freedom (pitch, roll, yaw, heave, forward movement and lateral movement) and enhanced visual displays have added fidelity to the simulation.

Regulating authorities, such as the FAA, began to allow simulators to be used for initial- and recurrent flight training. As the simulators got more sophisticated, more training was allowed on them. Today, state-of-the art flight simulators allow zero-flight-time transitions. This means that pilots with a certain minimum flight experience (typically, pilots already holding a Commercial Pilot License and a type rating) may receive an entire cross-training to a different type-rating (including landing training) in the simulator and perform the first actual landing in the new aircraft type during scheduled services.

As the available technology continues to improve, there appear to be no limits to fidelity in flight simulators – this, however, has created some problems. Teunisson (1999) holds that in the past any new technological development was implemented into flight simulators – regardless of whether this made any sense or not.

He refers to this as simulators being driven by technology – i.e. a *development-pull by technology*. He continues that it would make more sense to base future simulator developments on training needs – i.e. a *development-push by training requirements*.

The issue of *how* and *what* should be simulated tie training methodology and simulation together. In the previous chapter, the author elaborated on effectiveness and efficiency of training. The choice of SFTD and how much fidelity should be built into the respective device/system become key aspects in this context.

Lee (2002) analyzed the above in great detail. He referenced the analogy of *head*, *hand* and *heart* to categorize human learning. Head signifying *cognitive* (thinking) aspects – hand *motor* learning aspects – and heart *attitudinal* aspects of learning. Depending on the primary aspect of learning involved, training methodology has to vary accordingly.

An important aspect in the above context is the concept of *fidelity*.

## Fidelity

Fidelity, in the sense of *degree of similarity between the training situation and the operational situation*, plays a vital role in developing the right type of training methodologies for the respective primary aspect of learning (i.e. cognitive – motor – attitudinal).

Lee pointed out that a wide variety of fidelity concepts and labels (e.g. equipment fidelity, environmental fidelity, psychological fidelity, physical similarity, realism, total context fidelity) in the training industry have resulted in some confusion and distraction from the important question of how fidelity may enhance – or hamper – intended training.

With regard to the aspect of learning, Lee suggested differentiating between *physical fidelity* (i.e. similarity in visual, spatial, kinesthetic characteristics) and *functional fidelity* (i.e. similarity in functional characteristics, such as the informational, or stimulus ↔ response options) of the respective training.

Lee found evidence that motor learning tasks require the use of actual equipment or high physical fidelity simulations; while cognitive learning tasks do not require a high degree of physical fidelity and can be taught on a variety of media (e.g. print media, computer-based-training, low fidelity SFTD), as long as the functional fidelity is ensured.

Fidelity requirements for attitudinal aspects of learning are more difficult to determine, as this depends to a large degree on the overall complexity of the training task(s) at hand and the situational context of the training. Often, a mix of physical and functional fidelity is required to achieve optimal training of attitudinal aspects.

Flight training is a good example of this: How much fidelity (physical and functional) does it take to create a training environment which results in “a proper attitude”? The trainee knows (at least subconsciously) that he will always walk away from any crash in a simulation. Whether this “sense of security” is offset by the potential stress of the training situation, as well as potential repercussions for poor performance by the trainee, is a continuing area of controversy within the training industry.

What all three aspects of learning (motor, cognitive and attitudinal) have in common is that they all aim at enabling the trainee to develop a *mental model* of the part(s) of the world that are being addressed by the training.

Mental models are what help humans in transferring experience and skill from one situation to another – in other words, apply things that were learned or experienced to real world situations. Highly complex real world applications (such as flying), require either a large number of mental models and/or highly flexible mental models.

An adequate number of and/or highly flexible mental models can only result from adequate experience and training. In aviation, simulations have been used extensively in an attempt to enhance training and/or substitute for experience.

The success of using simulators in flight training is undisputed. Numerous studies (see next sub-chapter below) have proved that use of flight simulators reduces flight training hours. However, there continues to be great controversy on exactly how much flight time can be substituted by simulation, what degrees of simulation fidelity are required, and whether there are any parts of flight training that should not be substituted by simulations.

The author has pointed out several times that the above questions are among the primary concerns surrounding the MPL-concept, but that this study is not attempting to provide answers to these questions. The goal of this study is to provide training managers with a reasonable starting point, in terms of required flight training hours (aircraft and simulator), from which to be able to try to find answers to these questions – and, ultimately, start the iterative process of developing a CBT program for the MPL.

With regard to the above, the final area that had to be considered as part of the *Review of Relevant Literature and Research* was past studies surrounding use of simulations to substitute flight hours on actual aircraft.

Substitution of Flight Hours by Simulation

The main reasons for substituting actual flight hours by simulations are economic. Simulators are much cheaper to operate (e.g. use less fuel, no air traffic control fees) and the actual aircraft do not have to be taken out of regular operations for training purposes.

The fact that simulators also provide for a much safer and more controlled training environment are also important considerations for using simulations rather than actual flight training. From a training point-of-view, this “greater control over ambient conditions”, is perhaps the greatest advantage of simulations.

Ultimately, however, the *bottom line* (i.e. cost effectiveness and efficiency) will determine whether simulations will be used or not. Consequently, most studies on substitution of flight hours by simulation focused on cost-effectiveness of flight simulators.

An excellent review of such studies can be found in Orlansky and String (1979). They distinguish between effectiveness (i.e. how effective is the training per se) and cost-effectiveness [(i.e. how much does the training cost) – analogous to *efficiency* as it was used in the *Training* subchapter above – see p. 32]. They point out that it is difficult to make an effectiveness analysis of flight simulations as the criteria on which to base flight proficiency have not been clearly formulated.

The only “true test” of whether the simulation is an adequate substitute for actual flight training is to compare the performance of the respective trainees in the actual aircraft upon completion of the training. To be able to make a comparison between trainees who trained on simulators versus actual aircraft, an extremely well-controlled training environment is required. Additionally, training progression of the respective students has to be followed closely as they move through the various stages of training.

Such a “controlled training environment” has, typically, been only available in the military. Consequently, most studies of cost-effectiveness of flight simulators have been conducted by the military.

Orlansky and String reviewed 33 studies that had been conducted between 1939 and 1977. The studies analyzed simulators for various military aircraft (fixed and rotary wing) and examined a variety of different training tasks for pilots with different levels of experience. More than half of these studies had been conducted after 1970.

For more transparency of the respective data, Orlansky and String tried to transform the results of the various studies into TERs (see *Training*, p. 35 above). Due to the design of some of the studies TERs could only be computed for 22 of the 33 studies.

The analysis of TERs led to the following conclusions (Orlansky and String, 1977, p.12):

> 1 – Flight simulators saved aircraft time – in 21 of the 22 studies, pilots trained on specific skills in simulators needed less time to perform these skills than pilots who had been trained on the same tasks only in aircraft
>
> 2 – Simulators were effective under many different conditions – training by simulators enhanced training regardless of prior experience level of trainees, aircraft type or task to be trained
>
> 3 – Effectiveness varied widely – the TERs varied from -0.4 to 2.8, depending on a multitude of different variables (e.g. training task, pilot experience) – the median TER was .48
>
> 4 – Effectiveness does not imply cost-effectiveness – the mere fact that simulators were effective for training did not necessarily imply they were worth their cost

In order to determine cost-effectiveness of simulations, the operating costs of the simulator have to be considered as well. One basic parameter to consider in this respect is the difference in operating costs of the simulator versus the actual aircraft. Orlansky and String referred to this as the *simulator/aircraft operating ratio,* and found this ratio to be between 0.05 and 0.20.

Generally, it makes sense to use a simulator whenever the TER is equal to or greater than the simulator/aircraft operating ratio. There are, however, some additional considerations such as procurement cost of the SFTD and marginal utility of the simulation.

Simulators, in particular Type 4 SFTDs, can be very expensive. Amortization of this cost requires extensive use of the SFTD over a certain minimum time. Orlansky and String found that, on average, the cost of procuring a flight simulator can be amortized in about two years.

With regard to marginal utility of simulation, Orlansky and String referred to a study conducted by Povenmire and Roscoe (1973). In this study simulator time was varied systematically to find the corresponding effects on cumulative TER and incremental TER for each variation in simulator time.

Povenmire and Roscoe found that there was a point at which the increase in TER dropped below the increase in simulator operating cost. In other words, at some point the additional cost of operating the simulator did not warrant the resulting training benefit → the *marginal utility of the simulator* had been reached.

Orlansky and String argue that any cost-effectiveness analysis of simulations must include an analysis of the marginal utility of the simulation device(s), and they criticize the fact that there has been very little analysis of marginal utilities of simulators in the past. The author believes that this lack of research is attributable to the complexity and cost involved in varying simulator time during training.

The final two areas Orlansky and String analyzed were varying degrees of fidelity and minimum flight hour requirements. Analysis of both areas proved to be inconclusive. They found that enhanced motion or visual displays often added little to the training effectiveness per se, but might improve pilot-acceptance of the SFTD. They emphasized the point that some flight training on the actual aircraft continued to be essential to an effective pilot training program.

Orlansky and String concluded that more in-depth research into the optimum use of SFTDs and fidelity requirements needed to be conducted. They also identified the need to establish the minimum amount of flight hours needed for particular training tasks.

Their conclusions sum up the motivation for conducting this study. The MPL has the potential to incorporate state-of-the-art equipment with the most advanced training methodologies. If applied properly, this could result in a safer, more effective, and more efficient training program.

To ensure the process is started in a systematic fashion, a reasonable base-line concerning minimum flight hour requirements is required. The author has held that flight instructors are currently the best source of information on this. An added benefit in involving the flight instructors at this early stage is that this should result in more acceptance of the MPL-concept on the part of the flight instructors as well.

Flight instructors will be the individuals who have to transform the MPL-concept into a workable training program – consequently, it is imperative to have the acceptance and approval of the flight instructor community if the MPL-concept is to succeed.

In summary of the *Review of Relevant Literature and Research,* the author found that a CBT-approach towards flight training is worth exploring. Advances in training methodologies and equipment, as well as the need for a more standardized and streamlined flight training concept, to accommodate the growing commercial aviation market, make this a good time for the MPL-concept.

One problem is that CBT is new territory in flight-training, and economic pressures may prompt managers to view the MPL more as a means to cut training costs, versus developing a *better* training program - "better" in the sense of being more efficient and effective, including safety and overall quality.

The author identified the basic question of "where" to start the iterative process of developing a competency-based flight training program, in terms of minimum flight training hours on actual aircraft and synthetic flight training devices. The author refers to this as base-line requirement and believes it is vital to have a well-founded base-line requirement to facilitate the CBT development process.

Too few or too many flight hours, as well as the wrong mix of actual versus synthetic flight, could either result in inadequate performance on the part of the trainees and/or be highly ineffective and inefficient.

The author holds that a good way to find this base-line is to survey experienced flight instructors on how many training hours they feel are required for the MPL. Flight instructors are, perhaps, the most qualified individuals to estimate the base-line requirement, as they have experience in training pilots. Additionally, flight instructors will have to become integrated into the MPL at some time anyhow – to do this as early as possible should improve their involvement and, thus, the overall process.

## Statement of the Hypotheses

It is hypothesized that there is general consensus among flight instructors that current flight crew licensing and training procedures can be improved.

It is further hypothesized that a significant portion (at least 50%) of the required flight training for the proposed Multi-Crew Pilot License can be conducted on synthetic flight training devices.

Finally, it is hypothesized that the initial flight training requirements for the proposed Multi-Crew Pilot License will require a significant number of flight training hours (at least 100) to be performed on an actual aircraft.

# CHAPTER III

# RESEARCH METHODOLOGY

## Research Design

The study used the triangulating method, combining quantitative and qualitative elements. The quantitative elements are descriptive in nature (i.e. the actual flight hour requirements, broken down into flight hours per specific training task and cumulative flight hours). The qualitative elements are co-relational – showing the personal assessments (on a scale of 1 – 7) of the flight instructors on the feasibility of the MPL-concept per se.

## Research Model

Initially, a review of the relevant literature and research was conducted to support the theoretical basis of the problem. In particular, basic concepts of training methodology, simulation, ab-initio flight training, as well as how ICAO creates international standards were reviewed.

To determine the base-line-requirement (i.e. flight-hour requirement) for the proposed MPL, a survey was administered to flight instructors. The flight instructors were asked to give their personal assessment on some basic questions surrounding the MPL-concept, as well as the minimum number of flight-hours (actual aircraft and SFTDs) they felt are required for the proposed MPL. The results of the surveys formed the primary data to test the hypotheses.

## Survey Population

A total of 32 individuals responded to the survey; four of which were not flight instructors, nor did these four individuals have any pilot training background; thus the responses of these respondents were taken out of the analysis.

Each of the remaining 28 respondents had given at least 250 hours of flight instruction, with the average experience as flight instructor being approximately 2700 hours. Only three of the respondents had less than 1000 hours of flight instructor experience.

Only one of the respondents had less than five years (the one individual had three years) of experience as a flight instructor, with the average experience being 15 years and three instructors having more than 30 years of experience.

The licensing background of the survey population was rather diverse. All but one respondent had either a JAA or a FAA instructor rating – with the one individual holding a New Zealand Instructor rating. The vast majority (26) held multiple instructor ratings (e.g. Flight Instructor and Instrument Flight Instructor) and one respondent held both, a FAA and JAA instructor ratings.

Seven respondents held a JAA Type Rating Instructor (TRI) and/or Type Rating Examiner (TRE) license. TRIs provide aircraft type-specific training whenever a pilot seeks to get a type-rating for a particular aircraft. TREs conduct the recurrent check-rides (generally in simulators) for pilots to keep their currency rating for a particular aircraft type.

The majority of the respondents were either German (15) or US (8) nationals; the remaining four respondents came from Austria (2), Canada and New Zealand. With the relatively low number of non-US and non-German respondents, the author deemed it appropriate to distinguish only between *US*, *German* and *Other* for analysis purposes (see Chapter below). Figure 4 is a graphical representation of the survey population, broken down by nationality.

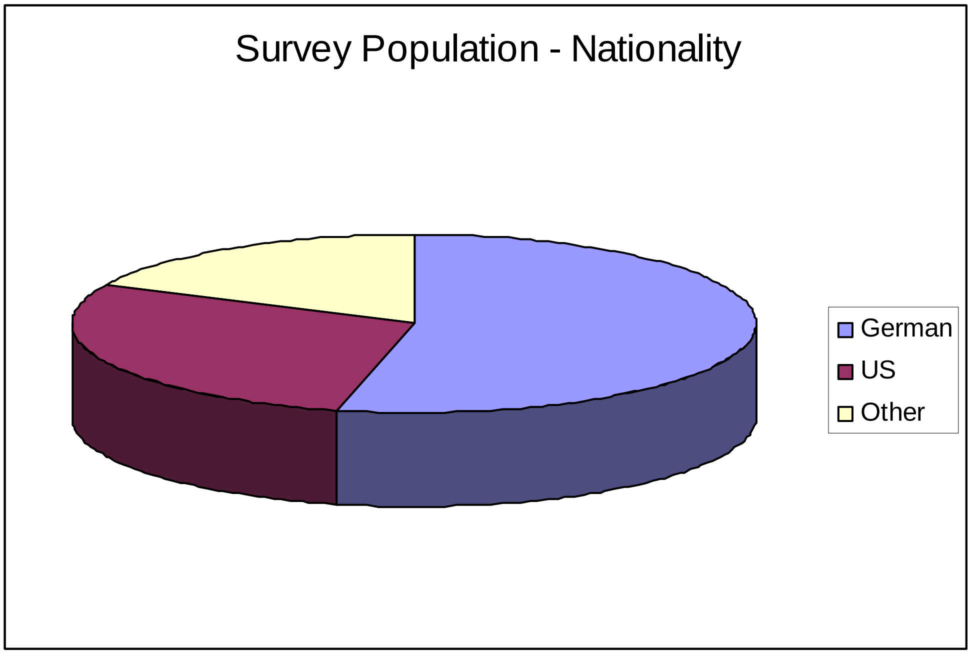


Figure 4. Survey Population by Nationality

The respective training backgrounds of the 28 respondents were as follows: Twelve had received their training through a traditional flight school training program - eight had been trained in the military - and eight had been trained through an ab-initio program. Figure 5 is the corresponding pie-chart for the personal training backgrounds of the respondents.

Four of the respondents had no experience as an instructor in an ab-initio training program. Of the remaining 24 instructors, one had at least some (50 hours) experience in ab-initio training; with the average experience in ab-initio training being 1709 hours.

In Block 26 of the survey, respondents were asked to give a personal assessment of their respective degree of familiarity with the proposed MPL-concept. Block 26 read: “I am familiar with the proposed Multi-Crew Pilot Licence (MPL) Concept” – and respondents had

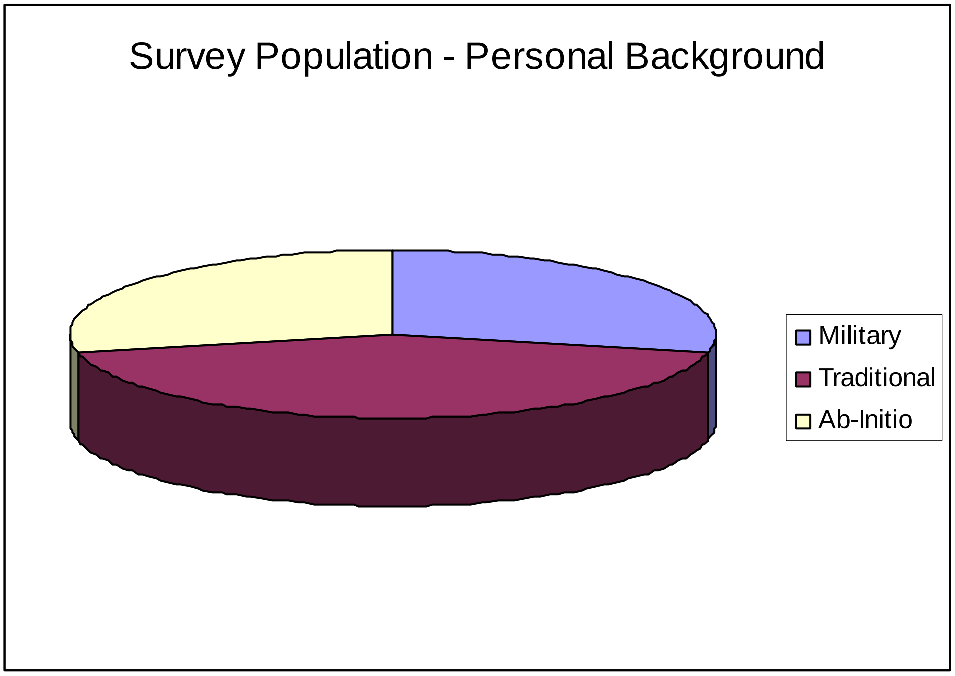


Figure 5. Survey Population by Personal Training Background

to choose a number on a scale of 1 (Completely Disagree) to 7 (Completely Agree).

As can be seen in Figure 6, a large majority (22) of the survey population expressed familiarity (5 or above) with the proposed MPL-concept.

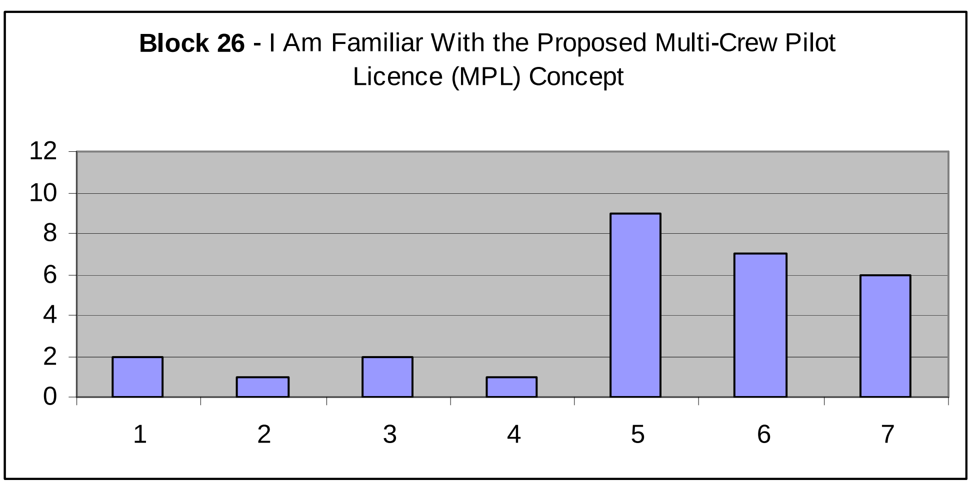


Figure 6. Histogram of Respondents' Assessment of Overall Familiarity with the MPL-Concept.

The answers of the remaining six respondents were spread from total disagreement with the statement (two respondents) to some disagreement (three respondents) and one respondent being undecided. The average and modal values were '5', with the standard deviation being 1.7 and the variation coefficient being 0.34 (moderate variation). Consequently, it can be said that the overall familiarity with the MPL-concept was relatively high among the respondents.

## Sources of Data

Data on potential substitution of flight hours by simulation was obtained from various articles found in the relevant literature and the world-wide-web.

Information concerning the proposed MPL-concept was provided by Mr. Uwe Harter (member of the ICAO FCLTP) and was also found on the world-wide-web.

The author contacted the IFALPA and the European Association of Airline Pilot Schools (EAAPS) for information on existing flight training programs and organizations.

## The Data Gathering Device

The data for this research project was obtained via the survey (see Appendix A). The survey consisted of 37 blocks, which were either questions or statements to which the respondent could enter data.

The 37 blocks can be divided into four parts:

- Part I (Blocks 1 – 14 of the survey) determined basic demographic data of the respondents (e.g. nationality, training background and flight instructor experience)
- Part II (Blocks 15 – 20 of the survey) asked the respondents to give a basic assessment of the overall required flight training hours to become an airline pilot

- Part III aimed at obtaining basic qualitative data on the MPL-concept as a whole – to do so, seven statements (Blocks 21 – 27 of the survey) were given, to which the respondent could enter his/her degree of agreement on a scale of *1* to *7* with the following, corresponding, options:

    - *1* - Completely Disagree
    - *2* – Strongly Disagree
    - *3* – Disagree
    - *4* – Undecided
    - *5* – Agree
    - *6* – Strongly Agree
    - *7* - Completely Agree

- Part IV (Blocks 28 – 36 of the survey) asked the respondents to provide actual flight hour requirements (aircraft and simulator), broken down into several areas, including the *core tasks* identified by the FCLTP

Additionally, there was also a Block (Block 37 of the survey) for *Free Text* comments.

The obtained data was compiled on various EXCEL spreadsheets (see Appendix B).

## Pilot Study

A pilot-survey was administered to a small number of flight instructors to provide a basis for the design of the final survey. Five flight instructors provided feedback on the questions and design of the survey.

## Instrument Pretest

The survey included some basic questions surrounding experience of the flight instructor being surveyed. This ensured that responses to the qualitative and quantitative questions could be put into proper perspective.

The author already pointed out above that some of the respondents did not have the required background as flight instructors and thus were not considered in the data-analysis.

## Distribution Method

The survey was provided in both paper and electronic form to flight training organizations and, also, directly to flight instructors. Potential respondents were given the choice to fill in the survey on paper or electronically and send the responses back to the author (anonymously, if so desired).

The *Vereinigung Cockpit* (VC) - German Cockpit Association - assisted with the distribution of the actual survey, by making the survey available on-line via the VC-website (www.vcockpit.de ) to be filled in and submitted directly on-line.

The survey was also announced in the 03-03/2006-issue of the VC-Info (bi-monthly periodical of the VC), with an article surrounding the proposed MPL-concept (Harter, 2006).

Finally, the author contacted several major US flight academies directly, asking them to announce the survey to their flight instructors.

## Instrument Reliability

The author had to rely on the integrity of the survey population to provide correct personal data and honest responses to the survey questions.

## Instrument Validity

The author was aware of the potential bias flight instructors may have towards simulation in general and the MPL in particular. One of the declared goals of the MPL is to streamline pilot training, which could result in fewer required flight training hours and/or substitution of flight hours by some form of simulation. This, in-turn, could mean potentially less work for flight instructors. The author included the qualitative questions in Part III of the survey (see Research Design above) to check for the general attitude towards the MPL.

Additionally, the author designed the survey such that the respondents had to provide an overall general assessment of flight-training requirements (Part II of the survey) and, additionally, a more specific (i.e. broken down into several training tasks) assessment of the training requirements (Part IV of the survey). The author felt this would give a better overall picture of the respective respondents' assessment, while also serving as a sort of "validation check". As the analysis in Chapter III and IV showed, there were a few discrepancies in some of the answers provided.

## Treatment of Data and Procedures

The data was compiled in various EXCEL-spreadsheets and basic statistical parameters (e.g. arithmetic means, variance, coefficient of variation – as well as geometric means and mode on some parameters) analyzed to determine what data required further analysis (e.g. Chi-square or ANOVA).

# CHAPTER IV

# RESULTS

The three main hypotheses of this project were:

1 - That there is general consensus among flight instructors that current flight crew licensing and training procedures could be improved.

2 - That a significant portion (at least 50%) of the required flight training for the proposed Multi-Crew Pilot License could be conducted on synthetic flight training devices.

3 - That the initial flight training requirements for the proposed Multi-Crew Pilot License would require a significant number of flight training hours (at least 100) to be performed on an actual aircraft.

## Hypothesis 1

The first hypothesis ("*general consensus among flight instructors that current flight crew licensing and training procedures could be improved*") was supported by the responses to Part III of the survey, in particular the assessment of statement number 22 of the survey.

As pointed out in the Chapter "Data Gathering Device" (see p. 54 above), respondents were asked to give their personal opinion to a number of statements (Blocks 21 – 27 of the survey) by assigning a number on a scale of *1* (completely disagree) to *7* (completely agree) to each statement.

Statement number 22 of the survey read: "*The current flight training and licensing requirements for Airline Pilots could be improved*". No respondent *completely disagreed,* while only one respondent *strongly disagreed*. Of the remaining 27 respondents, nine *agreed*, seven *strongly agreed* and eleven *totally agreed*. Figure 7 is a graphical representation of the responses to Block 22.

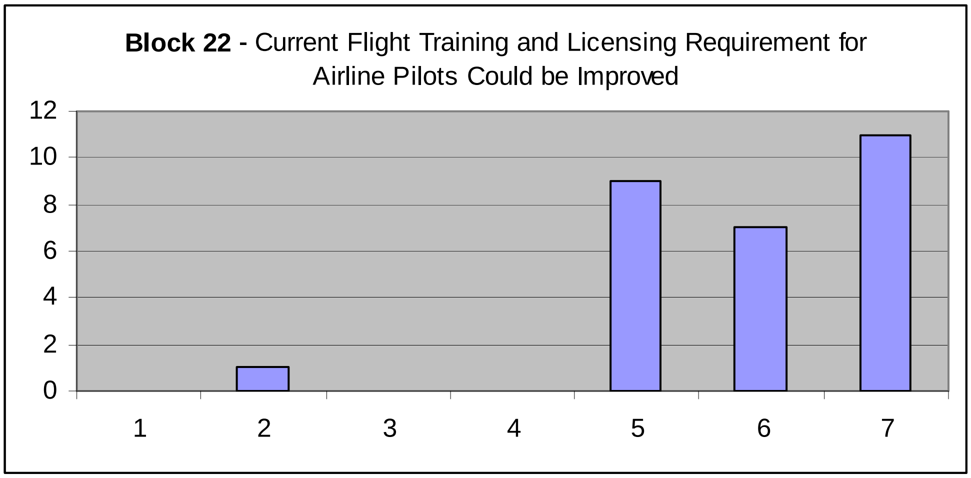


*Figure 7*. Histogram of Responses (*1* through *7*) to Block 22 of the Survey.

The arithmetic mean of all replies was 5.9, the geometric mean was 5.8 and the mode was 7. The standard deviation was 1.1 – resulting in a relatively low coefficient of variation of 0.19 – which is indicative of a fairly low dispersion of replies. Please refer to Appendix B for the respective spreadsheet on the training assessment.

The author conducted a Chi-Square analysis for goodness of fit of the data (see Sub-Chapter "Block 22", p. 78 below), with the expected value being a *4* (i.e. *undecided*). The resulting value for Chi-Square was 35, with a Coefficient of Contingency ('C') of 0.75. [NOTE: The maximum possible Coefficient of Contingency ($C_{max}$) for the entire Goodness of Fit Test surrounding the data from Part III of the survey was 0.93].

Hypothesis 2

The second hypothesis ("*at least 50% of the required flight training for the proposed Multi-Crew Pilot License could be conducted on SFTDs*") was not supported by the data provided in the surveys.

Statement number 25 of the survey read: ”*Most of the flight training for an Airline Pilot could be conducted on a flight training/simulation device, rather than on an actual aircraft.*” Only six of the respondents expressed some degree of agreement with the above statement – of these six, one *completely agreed*, one *strongly agreed*, and four *agreed*.

Two respondents were *undecided* and of the remaining twenty respondents, ten *completely disagreed*, four *strongly disagreed* and six *disagreed*. Figure 8 is the corresponding histogram for the responses to Block 25.

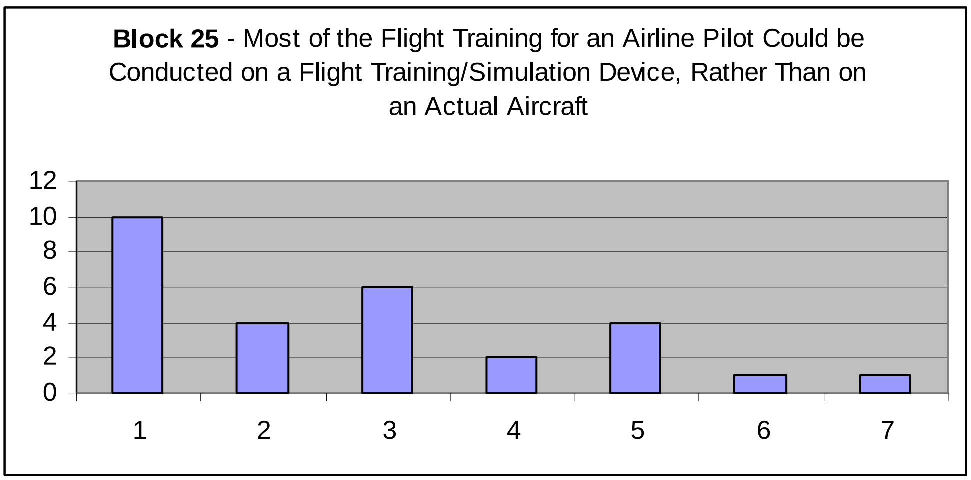


*Figure* 8. Histogram of responses (*1* through *7*) to Block 25 of the Survey.

The average and modal values were 2.75 and 1 respectively. The standard deviation was 1.7 – resulting in a relatively high coefficient of variation of 0.6 (→ high dispersion of responses).

The above findings were also supported by the results of the Chi-Square analysis (see Sub-Chapter “Block 25”, p. 82, later in this chapter). The resulting values for Chi-Square and C were much lower at 15.5 and 0.6 respectively.

The area of potential substitution of flight training in an actual aircraft by training in a SFTD was also covered by Part II and Part IV of the survey. In Part II of the survey, instructors were asked to give their personal assessment on how many total hours of flight instruction student-pilots should receive before they could be cleared to enter airline flight training as Co-Pilot Trainees – Block 18 of the survey specifically asked how many of these hours could be substituted on a SFTD.

In Blocks 28 – 36 (Part IV) of the survey, respondents were asked to give a more detailed breakdown of their personal assessment on how many training hours would be required for various core-tasks and how many of these hours could be substituted on a SFTD.

The respective responses to Blocks 18 and 28-36 do not match for each respondent. In fact, thirteen respondents entered a higher number of SFTD-substitution hours in Part IV than in Part II of the survey. The author has analysed this in more detail later in Chapter V. As far as the second hypothesis is concerned, the relative number of potential substitution-hours (expressed in percent of the total training hours) was of relevance.

Neither in Block 18, nor in Blocks 28-36, did the majority of the respondents feel that 50% or more of the flight training could be conducted on SFTDs. In Part II six respondents – in Part IV seven respondents - listed an overall average substitution rate of 50% or more.

The average substitution rates were 36% in Part II and 44% in Part IV. There was a very large spread in the responses to both parts of the survey (low 11% in Part II and 14% in Part IV – high in Part II 70% and 73% in Part IV respectively) and the coefficient of variation was moderate at 0,42 (Part II) and 0,36 (Part IV). Table 1 summarizes the responses to the training hour requirements.

Table 1

*Training Hour Assessment (Total Hours, Trainig Hours in Actual Aircraft, Training Hours in SFTDs and Percentage SFTD-Hours of Total Hours)*

| RESPONDENT NUMBER | TOTAL TRAINING HOURS | | TRAINING HOURS IN ACTUAL AIRCRAFT | | TRAINING HOURS IN SFTD | | PERCENTAGE SFTD-HOURS OF TOTAL | |
|---|---|---|---|---|---|---|---|---|
| | **Part II** | **Part IV** | **Part II** | **Part IV** | **Part II** | **Part IV** | **Part II** | **Part IV** |
| 1 | 250 | 300 | 125 | 154 | 125 | 146 | 50% | 49% |
| 2 | 150 | 150 | 118 | 118 | 32 | 32 | 21% | 21% |
| 3 | 250 | 295 | 125 | 150 | 125 | 145 | 50% | 49% |
| 4 | 250 | 250 | 150 | 111 | 100 | 139 | 40% | 56% |
| 5 | 200 | 235 | 100 | 75 | 100 | 160 | 50% | 68% |
| 6 | 200 | 305 | 100 | 89 | 100 | 216 | 50% | 71% |
| 7 | 260 | 99 | 160 | 27 | 100 | 72 | 38% | 73% |
| 8 | 190 | 195 | 140 | 116 | 50 | 79 | 26% | 40% |
| 9 | 325 | 325 | 98 | 98 | 227 | 227 | 70% | 70% |
| 10 | 180 | | 100 | | 80 | | 44% | |
| 11 | 250 | 240 | 200 | 189 | 50 | 51 | 20% | 21% |
| 12 | 280 | | 182 | | 98 | | 35% | |
| 13 | 300 | 300 | 185 | 190 | 115 | 110 | 38% | 37% |
| 14 | 250 | 250 | 160 | 160 | 90 | 90 | 36% | 36% |
| 15 | 300 | 210 | 175 | 85 | 125 | 125 | 42% | 59% |
| 16 | 360 | 360 | 310 | 310 | 50 | 50 | 14% | 14% |
| 17 | 300 | 260 | 145 | 105 | 155 | 155 | 52% | 60% |
| 18 | 265 | 265 | 164 | 164 | 101 | 101 | 38% | 38% |
| 19 | 500 | 150 | 445 | 95 | 55 | 55 | 11% | 37% |
| 20 | 275 | 275 | 200 | 200 | 75 | 75 | 27% | 27% |
| 21 | 270 | 245 | 170 | 145 | 100 | 100 | 37% | 41% |
| 22 | 250 | 250 | 200 | 197 | 50 | 53 | 20% | 21% |
| 23 | 550 | 550 | 285 | 285 | 265 | 265 | 48% | 48% |
| 24 | 260 | 230 | 150 | 120 | 110 | 110 | 42% | 48% |
| 25 | 350 | 295 | 250 | 195 | 100 | 100 | 29% | 34% |
| 26 | 240 | 240 | 140 | 140 | 100 | 100 | 42% | 42% |
| 27 | 500 | 237 | 420 | 156 | 80 | 81 | 16% | 34% |
| 28 | 500 | 201 | 410 | 111 | 90 | 90 | 18% | 45% |
| | | | | | | | | |
| **Arithmetic Means** | **295** | **258** | **193** | **145** | **102** | **113** | **36%** | **44%** |
| **Standard Deviation** | **101** | **81** | **97** | **60** | **74** | **56** | **16%** | **16%** |
| **Coefficient of Variation** | **0,34** | **0,31** | **0,50** | **0,41** | **0,69** | **0,5** | **42%** | **0,36** |

Note. Two respondents (Numbers 10 and 12) did not complete Part IV of the survey; thus there is no data in the respective fields.

It is important to note, however, that while most respondents did not agree that *most* of the flight training could be substituted, they still felt that a certain portion (one average, a minimum of one-third) of the training could be conducted on some form of SFTD.

Hypothesis 3

The third hypothesis ("*A significant number of flight training hours - at least 100 - to be performed on an actual aircraft*") was supported by the results of the survey. Analogous to the analysis surrounding Thesis 2 above, Part II (in particular, Blocks 15-18) and IV (in particular, Blocks 28-36) of the survey provided data for the analysis of Thesis 3.

The respondents' assessment of flight hour requirements varied between Part II and IV, corresponding to the differences the author has already addressed above. Again, further analysis of this can be found later in this chapter.

As far as training hours on actual aircraft was concerned, in Part II of the survey only one of the flight instructors surveyed felt that less than 100 hours would be necessary to prepare a student pilot to fly as a first officer in an airline cockpit; however, with 97.5 hours, the respective respondent's assessment was very close to the 100-hour mark (see Table 1 above).

In Part IV of the survey, six respondents felt that less than 100 hours would be required, with one respondent going as low as 27 hours.

The overall spread of the data provided was fairly large with the respective low values at 98 hours (Part II) and 27 hours (Part IV) and the high values at 445 hours (Part II) and 310 hours (Part IV). Standard deviation was 97 hours (Part II) and 60 hours (Part IV), resulting in coefficients of variation of 0.50 (Part II) and 0.41 (Part IV), indicative of moderate to high dispersion of data (see also Appendix C for more detailed statistical analysis).

Testing of the three main hypotheses was only part of this study. The other main goal of the study was to determine a base-line requirement, in terms of flight training hours, for the proposed MPL.

## Base-Line Flight Hour Requirement

The basic flight hour requirement was covered by Part II of the survey (Blocks 15 – 20) and the results of the data provided in this area were (arithmetic means):

295 hours total training – of these, 193 hours on actual aircraft (with a minimum of 150 hours on complex aircraft and 108 hours on multi-engine aircraft – NOTE: multi-engine aircraft normally are also complex aircraft) and 102 on SFTDs (in particular, 10 hours Type I SFTD, 9 hours Type II SFTD, 33 hours Type III SFTD and 50 hours Type IV SFTD). The instructors recommended a minimum of 274 landings, of which 92 could be performed on a SFTD.

To provide a more differentiated analysis of the base-line requirement, Part IV of the survey (Blocks 28 – 36) asked the participating flight instructors to give a more detailed breakdown of flight hour requirements for the areas of training and, additionally, estimate how much of the respective training could be substituted by what type of simulation device.

The particular areas of training were based on the *core-tasks*, as identified by the FCLTP, and the feedback provided by the flight instructors who participated in the pilot survey (see Chapter III – Sub-Chapter “Pilot Study”, p. 55 above).

As pointed out earlier in the Chapters on Thesis 2 and 3, some responses given in Part IV varied significantly from the corresponding responses in Part II of the survey (the author analyzed the potential reasons for this in more detail in Chapter IV). For example, five respondents listed substantially less required training hours in Part IV than Part II (up to 350 hours difference). .

Also, two respondents did not complete Part IV of the survey at all. This has to be kept in mind when relating the data of Part IV to Part II of the survey. As the respective answers of these two individuals to Part II of the survey were along the average values of the entire survey population, the author felt it was acceptable to include these two surveys for the overall analysis of the data. Table 2 summarizes the differences between the responses given in Part II and Part IV of the survey, surrounding the respective assessment of flight-hour requirements.

Closer analysis of the variances between responses to Part II and Part IV of the survey (see also Table 1 above) showed that the main discrepancies were in the area of flight hours on actual aircraft and not in the area of training hours on SFTDs. The data relating to flight hours on actual aircraft differed significantly (20 or more hours) in fifteen responses – versus only six responses relating to hours on SFTDs. Again, the author refers the reader to Chapter IV for analysis on the potential reason(s) for the discrepancies.

Interesting to note is that the overall number of training hours on SFTDs actually increased in Part IV (113 versus 102 in Part IV), resulting in an over-proportionate decrease in hours on actual aircraft (145 versus 193 in Part IV).

Consequently, the overall rate of SFTD-hours for Blocks 28-26 was higher (44%) than the corresponding rate for the overall training (36%).

Table 2

*Differences in the Responses Relating to Flight Hour Requirements as Assessed by Parts II and IV of the Survey*

| RESPONDENT | Date / Time | DELTA TOTAL TRAINING HOURS | DELTA TRAINING HOURS IN ACTUAL AIRCRAFT | DELTA TRAINING HOURS IN SFTDs | DELTA PERCENTAGE SFTD-HOURS OF TOTAL TRAINING |
|---|---|---|---|---|---|
| 1 | 09.09.-14:30 | 50 | 29 | 21 | -1% |
| 2 | 09.09.-15:21 | 0 | 0 | 0 | 0% |
| 3 | 11.04.-06:05 | 45 | 25 | 20 | -1% |
| 4 | 11.04.-18:32 | 0 | -39 | 39 | 16% |
| 5 | 11.04.-21:19 | 35 | -25 | 60 | 18% |
| 6 | 12.04.-19:40 | 105 | -11 | 116 | 21% |
| 7 | 20.04.-02:56 | -161 | -133 | -28 | 35% |
| 8 | 28.04.-12:21 | 5 | -24 | 29 | 14% |
| 9 | 04.05.-08:19 | 0 | 0 | 0 | 0% |
| 10 | 05.05.-09:52 | | | | |
| 11 | 10.05.-12:48 | -10 | -11 | 1 | 1% |
| 12 | 16.05.-16:11 | | | | |
| 13 | 13.06.-15:32 | 0 | 5 | 5 | -1% |
| 14 | 16.06.-05:42 | 0 | 0 | 0 | 0% |
| 15 | 17.06.-15:29 | -90 | -90 | 0 | 17% |
| 16 | 23.05.-23:17 | 0 | 0 | 0 | 0% |
| 17 | 23.06.-11:21 | -40 | -40 | 0 | 8% |
| 18 | 08.07.-17:39 | 0 | 0 | 0 | 0% |
| 19 | 12.07.-18:25 | -350 | -350 | 0 | 26% |
| 20 | 13.07.-08:35 | 0 | 0 | 0 | 0% |
| 21 | 14.07.-12:26 | -25 | -25 | 0 | 4% |
| 22 | 17.07.-13:25 | 0 | -3 | 3 | 1% |
| 23 | 18.07.-11:41 | 0 | 0 | 0 | 0% |
| 24 | 18.07.-12:51 | -30 | -30 | 0 | 6% |
| 25 | 18.07.-12:58 | -55 | -55 | 0 | 5% |
| 26 | 18.07.-14:59 | 0 | 0 | 0 | 0% |
| 27 | 27.07.-12:54 | -263 | -264 | 1 | 18% |
| 28 | 04.08.-12:26 | -299 | -299 | 0 | 27% |
| | | | | | |
| | Arith. Means | -37 | -48 | 11 | 8% |

*Note*. Respondents 10 and 12 did not complete Part IV of the survey; consequently, there is no data on potential differences from these two respondents.

An analysis of variation (ANOVA) was conducted (refer to Appendix D for the entire results) on the specific flight hour assessments from each respondent on all nine tasks identified in Blocks 28-36 of the survey. The ANOVA-results showed a wide spectrum of training hour allocations – both in total hours and potential substitution of training hours on actual aircraft by hours on SFTDs.

To make the overall data more comparable, an additional ANOVA of the relative rate of substitution (hours on actual aircraft by hours on SFTDs) was also done. The results of this analysis can also be found in Appendix D.

It is worth mentioning that, compared to Part II of the survey, the coefficients of variation were lower in all areas of Part IV – thus, the dispersion of data was lower in Part IV.

In summary, the following basic results of Part IV of the survey are worth noting:

- The overall flight training requirement (arithmetic means) for the core tasks was 258 training hours
- The overall potential substitution of training hours on actual aircraft with hours on SFTDs was 112 hours
- The three areas requiring the most hours of instruction were: (1) Instrument Flying (85 hours) – (2) Basic Flying (38 hours) and (3) CRM/CCC (31 hours).
- The largest coefficients of variation were in the areas of Abnormal Situations (1,0) and Auto Pilot/Flight Director (0,94)
- The three areas with the highest potential substitution rates of actual aircraft hours with SFTDs were (1) FMS (77%) - (2) Auto Pilot/Flight Director (66%) and (3) CRM (64%)
- All respondents felt that SFTDs could be used, at least to some degree, in the following areas: Instrument Flying, Multi-Engine Abnormals and Auto Pilot/Flight Director – and most felt that SFTDs could be used for CRM and FMS training
- About half of the respondents felt SFTDs could be used in the areas Multi-Engine Basic Flying, Abnormal Situations; while less than half thought SFTDs were an option in the areas of Basic Flying and Unusual Attitudes

- There was great variance concerning the particular type of SFTD (I – IV) that could be used for a particular area of training – the only trends in this respect were that for CRM- training a Type III or IV SFTD should be used, while thirteen respondents felt that a Type I or II SFTD would be sufficient for FMS-training

After having listed the basic results to the three theses and the base-line flight hour requirement, a more detailed analysis of the data with regards to the particular background of the respondents (i.e. nationality and training) was conducted. The three demographic parameters the author selected for detailed analysis were:

1 – Nationality

2 – Training Background

3 – Training Experience

Due to the rather high dispersion of data on specific training tasks, a detailed analysis of the specific training assessments was not done. Instead, the author felt an analysis of the overall training assessment (Part III of the survey), as well as the base-line flight training requirement assessment (Parts II and IV of the survey) was sufficient to determine if there were any correlations between demographic parameters and the data provided by the respective respondents.

## Analysis by Nationality

As pointed out in Chapter II (Survey Population), the majority of the respondents were either from Germany or the US – thus, a distinction between German, US and Other was done. Table 3 shows several statistical parameters for the data from Part III of the survey, broken down by nationality:

Table 3

*Analysis of Training Assessment (Part III of Survey) Responses by Nationality*

| **Population** | **Parameter** | **21** | **22** | **23** | **24** | **25** | **26** | **27** |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| German | arith. Means | 4,1 | 6,2 | 4,5 | 5,1 | 2,3 | 5,1 | 4,3 |
| US | arith. Means | 4,2 | 5,6 | 4,6 | 5,6 | 3,2 | 4,5 | 5,6 |
| Other | arith. Means | 3,6 | 5,6 | 3,4 | 5,6 | 3,2 | 6 | 5,6 |
| | | | | | | | | |
| **Total Pop.** | **arith. Means** | **4,1** | **5,9** | **4,4** | **5,3** | **2,7** | **5,1** | **4,9** |
| | | | | | | | | |
| German | Mode | 5 | 7 | 6 | 6 | 1 | 5 | 5 |
| US | Mode | 5 | 7 | 7 | 5 | 3 | 5 | 7 |
| Other | Mode | 3 | 5 | 2 | 6 | 3 | 7 | 7 |
| | | | | | | | | |
| **Total Pop.** | **Mode** | **5** | **7** | **6** | **6** | **1** | **5** | **7** |
| | | | | | | | | |
| German | stand. Dev. | 1,4 | 0,8 | 1,9 | 1,6 | 1,6 | 1,6 | 1,2 |
| US | stand. Dev. | 1,7 | 1,6 | 2,2 | 1 | 1,6 | 1,8 | 2,2 |
| Other | stand. Dev. | 0,8 | 0,8 | 2,1 | 1 | 2 | 1,3 | 1,9 |
| | | | | | | | | |
| **Total Pop.** | **stand. Dev.** | **1,4** | **1,1** | **2,1** | **1,4** | **1,7** | **1,7** | **1,8** |
| | | | | | | | | |
| German | Coeff. Of Var. | 0,34 | 0,13 | 0,42 | 0,31 | 0,69 | 0,31 | 0,28 |
| US | Coeff. Of Var. | 0,4 | 0,28 | 0,43 | 0,18 | 0,5 | 0,4 | 0,39 |
| Other | Coeff. Of Var. | 0,22 | 0,14 | 0,62 | 0,18 | 0,62 | 0,22 | 0,34 |
| | | | | | | | | |
| **Total Pop.** | **Coeff. Of Var.** | **0,35** | **0,19** | **0,47** | **0,26** | **0,63** | **0,33** | **0,37** |

Overall, the author did not note any significant correlation between nationality and the data provided in Part III of the survey. There were no variances equal or greater than *1* in Blocks 21, 22, 24 and 25 of the survey. The largest variance was found in Block 26 between *US* and *Other* (1.5) and Block 27, where the *German* respondents agreed, on average, 1.3 points less than the *US*- and *Other* respondents.

The respective respondents' assessment of required training hours (see Table 4 below) differed significantly between the three nationality groups. The most significant variances were found in the responses to Part II. German respondents listed, by far, the fewest overall training hours (266) in Part II (versus US-307 and Others-360) – as well as the fewest hours on actual aircraft (165 – versus US-187 and Others-270).

Table 4

*Analysis of Required Training Hours (Parts II and IV of Survey) by Nationality*

| Nationality | Total Training Hours - Part II | Total Training Hours Part IV | Training Hours in Actual Aircraft Part II | Training Hours in Actual Aircraft Part IV | Training Hours in SFTDs Part II | Training Hours in SFTDs Part IV | Percentage SFTD-Hours of Total Hours Part II | Percentage SFTD-Hours of Total Hours Part IV |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| German | 266 | 268 | 162 | 150 | 104 | 118 | 38% | 43% |
| | | | | | | | | |
| US | 307 | 247 | 194 | 125 | 113 | 122 | 39% | 51% |
| | | | | | | | | |
| Other | 360 | 244 | 285 | 170 | 75 | 74 | 25% | 33% |
| | | | | | | | | |
| **Total Pop** | **295** | **258** | **193** | **145** | **102** | **113** | **36%** | **44%** |

The numbers were a lot closer in Part IV. Interesting to note is that the German responses to Part II and IV are very similar, while *US* and *Other* flight instructors reduced their assessment on the number of hours required on actual aircraft significantly from Part II to IV. Potential rates of substitution (i.e. hours on actual aircraft by hours on SFTDs) varied significantly for both responses to Part II and Part IV (up to 18% difference). *US* respondents gave the highest rates (39% in Part II and 51% in Part IV), and all three groups had significant rate increases from Part II to Part IV.

The next distinguishing demographic parameter for a more detailed analysis was the training background of the flight instructors.

## Analysis by Training Background

Respondents had been asked to indicate through what type of training organization they had received the majority of their flight training – Military, Traditional or Ab-Initio. The author gave a brief review of flight training, in particular ab-initio training, in Chapter II (pp. 32 -38) of this study. Ab-initio programs originated in Europe and did not really begin in other countries (e.g. the US) until the mid 1990s. With this in mind, it is not surprising that the eight respondents who went through an ab-initio training program all came from Germany.

Similar to the analysis surrounding nationality, there was no significant correlation between training background and training assessment by the respondents. Compared to the nationality analysis, there were slightly more variances equal to or higher than *1* (Blocks 21, 23, 24, 26 and 27), but no one exceeded 1.5. See Table 5.

Table 5

*Analysis of Training Assessment (Part III of Survey) Responses by Training Background*

| Population | Parameter | Block 21 | Block 22 | Block 23 | Block 24 | Block 25 | Block 26 | Block 27 |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Traditional | Arith. Mean | 3,6 | 6,2 | 4,4 | 4,8 | 2,8 | 5,7 | 4,8 |
| Military | Arith. Mean | 4,6 | 5,3 | 5 | 6 | 3,1 | 4,7 | 5,6 |
| Ab-Initio | Arith. Mean | 4,2 | 6 | 3,6 | 5,3 | 2,2 | 4,6 | 4,2 |
| | | | | | | | | |
| **Total Pop.** | **arith. Means** | **4,1** | **5,9** | **4,4** | **5,3** | **2,7** | **5,1** | **4,9** |
| | | | | | | | | |
| Traditional | Mode | 3 | 7 | 2 | 5 | 1 | 5 | 7 |
| Military | Mode | 5 | 5 | 6 | 6 | 1 | 6 | 7 |
| Ab-Initio | Mode | 3 | 5 | 2 | 6 | 1 | 3 | 5 |
| | | | | | | | | |
| **Total Pop.** | **Mode** | **5** | **7** | **6** | **6** | **1** | **5** | **7** |
| | | | | | | | | |
| Traditional | stand. Dev. | 1,8 | 1,4 | 2,2 | 1,6 | 1,8 | 0,9 | 1,8 |
| Military | stand. Dev. | 1,1 | 0,9 | 1,3 | 0,6 | 1,8 | 1,6 | 1,2 |
| Ab-Initio | stand. Dev. | 0,9 | 0,8 | 2,1 | 1,4 | 1,4 | 2 | 1,8 |
| | | | | | | | | |
| **Total Pop.** | **stand. Dev.** | **1,4** | **1,1** | **2,1** | **1,4** | **1,7** | **1,7** | **1,8** |
| | | | | | | | | |
| Traditional | Coeff. Of Var. | 0,5 | 0,22 | 0,5 | 0,33 | 0,64 | 0,16 | 0,37 |
| Military | Coeff. Of Var. | 0,24 | 0,17 | 0,26 | 0,1 | 0,58 | 0,34 | 0,21 |
| Ab-Initio | Coeff. Of Var. | 0,21 | 0,13 | 0,58 | 0,26 | 0,64 | 0,43 | 0,43 |
| | | | | | | | | |
| **Total Pop.** | **Coeff. Of Var.** | **0,35** | **0,19** | **0,47** | **0,26** | **0,63** | **0,33** | **0,37** |

Data on training hour requirements varied less based on training background versus nationality (refer to Table 6 below). The differences in potential rates of substitution for hours on actual aircraft by hours on SFTDs were also much smaller (maximum of 6% difference).

Table 6

*Analysis of Required Training Hours (Parts II and IV of Survey) by Training Background*

| Population Parameter | Total Training Hours - Part II | Total Training Hours - Part IV | Training Hours in Actual Aircraft Part II | Training Hours in Actual Aircraft Part IV | Training Hours in SFTDs Part II | Training Hours in SFTDs Part IV | Percentage SFTD-Hours of Total Hours Part II | Percentage SFTD-Hours of Total Hours Part IV |
|---|---|---|---|---|---|---|---|---|
| Ab-Initio | 278 | 294 | 171 | 164 | 107 | 130 | 37% | 42% |
| Military | 300 | 266 | 193 | 152 | 107 | 114 | 36% | 41% |
| Traditional | 302 | 230 | 207 | 129 | 95 | 101 | 35% | 47% |
| **Total Pop** | **295** | **258** | **193** | **145** | **102** | **113** | **36%** | **44%** |

Interesting to note is that the ab initio-respondents felt more training hours were required to train students for the tasks identified in Blocks 28-36 (Part IV) - versus Blocks 15-20 (Part II) – of the survey. These instructors did reduce the required number of hours in the actual aircraft from Part II to IV; however, they offset this by a large increase in training hours on SFTDs from Part II to IV.

The fact that the instructors with an ab-initio background actually increased the training requirement from the basic assessment in Part II of the survey to the more specific assessment in Part IV, prompted the author to conduct further analysis of the flight training hour requirement. In particular, distinguishing between respondents with experience in ab-initio training (as an instructor) - and those who had little or no experience in ab-initio training.

## Analysis by Experience in Ab-Initio Training

The overall average experience in ab-initio training among the survey population was 1710 hours. Based on this number, the author distinguished between instructors who had

1500 hours or more experience in ab-initio training (10 respondents) and instructors who had less (18 respondents). Table 7 summarizes the respective required training hour assessments of both groups.

Table 7

*Analysis of Required Training Hours (Parts II and IV of Survey) by Ab-Initio Experience*

| **Population** - Statistical Parameter | **Total Training Hours Part II** | **Total Training Hours Part IV** | **Training Hours in Actual Aircraft Part II** | **Training Hours in Actual Aircraft Part IV** | **Training Hours in SFTDs Part II** | **Training Hours in SFTDs - Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **>=1500 hours experience** | | | | | | | | |
| Arith. Mean | 326 | 226 | 231 | 136 | 95 | 90 | 29% | 40% |
| Stand. Deviat. | 118 | 33 | 120 | 39 | 25 | 30 | 12% | 13% |
| Coeff. Of Var. | 0,36 | 0,15 | 0,52 | 0,29 | 0,26 | 0,33 | | |
| **<1500 hours experience** | | | | | | | | |
| Arithm. Mean | 278 | 275 | 167 | 148 | 111 | 127 | 40% | 46% |
| Stand. Deviat. | 85 | 93 | 60 | 69 | 56 | 62 | 13% | 17% |
| Coeff. Of Var. | 0,31 | 0,34 | 0,36 | 0,47 | 0,5 | 0,49 | | |
| **Total Population** | | | | | | | | |
| Arith. Mean | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Deviat. | 101 | 81 | 80 | 61 | 74 | 56 | 16% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | | |

The instructors with 1500 or more hours of experience in ab-initio training did not follow the trend of the instructors who had received their pilot-training through an ab-initio program. On the contrary, those respondents more experienced in ab-initio training as instructors, listed significantly less required training hours (226) in Part IV – versus Part II (326 hours).

Interesting to note is that the dispersion of data relating to Part II of the survey was rather high (coefficient of variation 0.36), but very low in Part IV (0.15). This suggests that the instructors with more experience in ab-initio programs had very similar concepts for the more specific training requirements surrounding the tasks identified in Blocks 26-35 of the survey – but, quite differing ideas on the overall requirements for a student pilot to reach proficiency as an airline co-pilot trainee.

The author has already referred to this apparent mismatch between data relating to Part II versus data relating to Part IV of the survey. Potential reasons for this were explored in Chapter V.

The next analysis focused on training-hour requirements based upon overall training experience (versus experience in ab-initio only) of the respondents.

## Analysis by Overall Experience in Flight Training

The overall experience level of the respondents was rather high. The author distinguished between instructors who had more than 5000 hours of flight-instructor experience (eighteen respondents) and those who had up to and including 5000 hours of instructor experience (ten respondents). Table 8 summarizes the respective training-hour assessment.

The training assessment by those respondents with less than 5000 hours of instructor experience was similar in Parts II and IV of the survey – while there was a significant difference in the respective assessment of the more experienced flight instructors (56 total training hours more in Part II versus Part IV).

The main variance between the two groups of instructors was in the area of training hours on actual aircraft – the more experienced instructors, on average, listed 61 more hours of training on actual aircraft in Part II and 24 more hours in Part IV respectively.

Table 8

*Analysis of Required Training Hours (Parts II and IV of Survey) by Total Experience*

| **Population** - Statistical Parameter | **Total Training Hours Part II** | **Total Training Hours Part IV** | **Training Hours in Actual Aircraft Part II** | **Training Hours in Actual Aircraft Part IV** | **Training Hours in SFTDs Part II** | **Training Hours in SFTDs - Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **≤5000 hours experience** | | | | | | | | |
| Arith. Mean | 251 | 248 | 153 | 134 | 98 | 114 | 39% | 46% |
| Stand. Deviat. | 50 | 101 | 55 | 59 | 50 | 66 | 14% | 19% |
| Coeff. Of Var. | 0,2 | 0,41 | 0,36 | 0,44 | 0,51 | 0,58 | 0,36 | 0,41 |
| **>5000 hours experience** | | | | | | | | |
| Arith. Mean | 319 | 263 | 214 | 158 | 105 | 105 | 33% | 40% |
| Stand. Deviat. | 112 | 84 | 106 | 61 | 50 | 51 | 13% | 13% |
| Coeff. Of Var. | 0,35 | 0,32 | 0,49 | 0,39 | 0,48 | 0,49 | 0% | 0% |
| **Total Population** | | | | | | | | |
| Arith. Mean | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Deviat. | 101 | 81 | 80 | 61 | 74 | 56 | 14% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | 39% | 0,36 |

The final analysis surrounding training hour requirements distinguished between respondents who were familiar with the MPL-concept and those who were not (see Table 9).

Table 9

*Analysis of Required Training Hours (Parts II and IV of Survey) by Familiarity with MPL-Concept*

| **Population** - Statistical Parameter | **Total Training Hours - Part II** | **Total Training Hours - Part IV** | **Training Hours in Actual Aircraft Part II** | **Training Hours in Actual Aircraft Part IV** | **Training Hours in SFTDs Part II** | **Training Hours in SFTDs Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **Familiar with MPL-Concept** | | | | | | | | |
| Arith. Mean | 295 | 260 | 190 | 150 | 105 | 110 | 36% | 42% |
| Stand. Deviat. | 99 | 87 | 93 | 64 | 54 | 57 | 15% | 16% |
| Coeff. Of Var. | 0,34 | 0,33 | 0,49 | 0,43 | 0,51 | 0,52 | 0% | 0% |
| **Unfamiliar with MPL-Concept** | | | | | | | | |
| Arith. Mean | 295 | 249 | 205 | 124 | 90 | 125 | 31% | 50% |
| Stand. Deviat. | 196 | 42 | 102 | 37 | 18 | 50 | 10% | 13% |
| Coeff. Of Var. | 0,66 | 0,17 | 0,5 | 0,3 | 0,2 | 0,4 | 0,32 | 0,26 |
| **Total Population** | | | | | | | | |
| Arith. Means | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Deviat. | 101 | 81 | 80 | 61 | 74 | 56 | 14% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | 39% | 0,36 |

There was relatively little difference between the two sets of data. The number of total training hours was very similar in both Parts II and IV. Differences were noted in the number of training hours on actual aircraft, where the respondents who were unfamiliar with the MPL-concept had a slightly higher number in Part II – but a slightly lower number in Part IV.

Interestingly, flight instructors familiar with the MPL-concept had a higher percentage of SFTD-hours in Part II (36% versus 31% assessed by the other respondents) – while in Part IV, the respective assessments were reversed (here respondents familiar with the MPL-concept felt 42% of the training could be conducted on SFTDs – the instructors unfamiliar with the MPL-concept had assessed 50% respectively).

After the detailed analysis of the training hour requirements, a further analysis of the training-assessment (Part III – Blocks 21 through 27 – of the survey), in particular, dispersion of data and Chi-Square analysis was conducted.

## Analysis of Training Assessment

As mentioned in the Chapter “The Data Gathering Device” (see p. 54), Part III of the survey consisted of a number of statements (Blocks 21 through 27), to which the respondents were asked to give their personal degree of agreement/disagreement on a scale of one to seven.

Table 10 gives a summary of the basic statistical parameters (i.e. Mode, arithmetic means, standard deviation and coefficient of variation) for Blocks 21 through 27.

Table 10

*Overall Statistical Data on Flight Training Assessment (Part III of Survey)*

| Parameter | Block 21 | Block 22 | Block 23 | Block 24 | Block 25 | Block 26 | Block 27 |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **Mode** | 5 | 7 | 6 | 6 | 1 | 5 | 7 |
| **geom. Means** | 3,8 | 5,8 | 3,7 | 5 | 2,2 | 4,6 | 4,5 |
| **arith. Means** | 4,1 | 5,9 | 4,4 | 5,3 | 2,7 | 5,1 | 4,9 |
| **Stand. Devia.** | 1,4 | 1,1 | 2,1 | 1,4 | 1,7 | 1,7 | 1,8 |
| **Coeff. Of Var.** | 0.35 | 0,19 | 0,47 | 0,26 | 0,63 | 0,33 | 0,37 |

A Chi-Square Goodness of Fit Test was conducted on the data obtained in Part III of the Survey.  For this analysis, the “expected values” corresponded to an even distribution of answers across the entire options (*1* through *7*).  A high Chi-Square and low *p-value*, thus, are indicative of distributions which strongly deviate from the expected even distribution.

The Spearman-Coefficient of Contingency (*C*) was also calculated for the respective Chi-Square results of the above analysis [the maximum Coefficient of Contingency ($C_{max}$) was 0.93 for the entire analysis].

In the following sub-chapters, the author has summarized some of the more significant results.  A histogram of the responses (Figures 9 through 15) and Chi-Square Results (Tables 11 through 16) were included for each of the respective survey blocks (except for a Chi-Square analysis of Block 26, as this would have served no useful purpose – see “Block 26”, p. 83 below).

Block 21

The statement in Block 21 read: "*The current flight training and licensing requirements for Airline Pilots are adequate*".

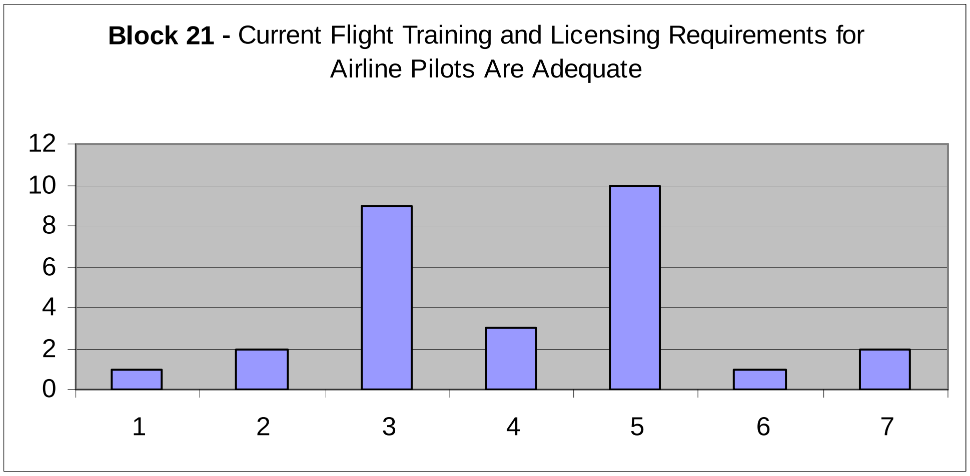


*Figure 9.* Histogram of responses (*1* through *7*) to Block 21 of the Survey.

Dispersion of data was moderate to high (coefficient of variation 0.35), indicative of fairly low consensus among the respondents. While the arithmetic means of 4.1 might have suggested that the respondents were undecided on this area, closer analysis showed that all but three respondents either disagreed or agreed to some degree. Figure 9 illustrates this "split" of opinions very nicely. The Chi-Square of 22 with C = 0.66 also confirmed this.

Table 11

*Chi-Square Test for Goodness of Fit – Block 21*

| Block 21 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| | | | | | | | |
| **Actual** | 1 | 2 | 9 | 3 | 10 | 1 | 2 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **22** **C = 0.66** $C_{max}$ 0.93
***p*-value 0,012**

Block 22

The statement in Block 22 of the survey read: "*The current flight training and licensing requirements for Airline Pilots could be improved*".

The respondent's assessment of the above statement was already analysed to some degree in the Sub-Chapter "Hypothesis 1" (see p. 58) earlier in this study. The respective histogram of the responses (*1* through *7*) was included on page 58. Dispersion of data was the lowest of all data-sets in Part III of the survey with a coefficient of variation of 0.19. The arithmetic means was 5.9 and the Chi-Square Test resulted was 22 with C = 0.75. All of these parameters indicated strong agreement of all respondents with the statement in Block 22.

Table 12

*Chi-Square Test for Goodness of Fit – Block 22*

| Block 22 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| | | | | | | | |
| **Actual** | 0 | 1 | 0 | 0 | 9 | 7 | 11 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **35** **C = 0,75** $C_{max}$ 0,93

***p*-value 0,0000**

Block 23

The statement in Block 23 of the survey read: "*Most of the experience gained as a Private Pilot has little value in Airline flight training*."

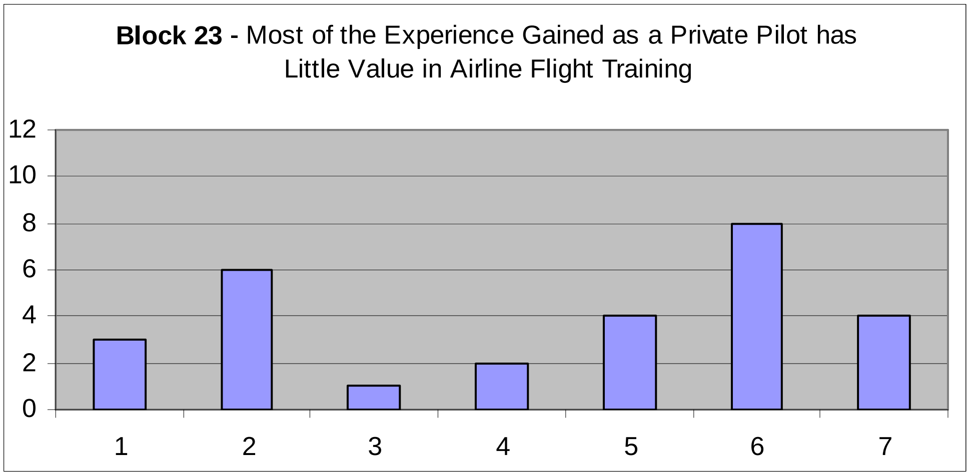


*Figure 10*. Histogram of responses (*1* through *7*) to Block 23 of the Survey.

Dispersion of data was high (coefficient of variation of 0.47). Chi-Square analysis yielded the lowest values for Chi-Square (8.5) and C (0.48), thus there was no significant trend in the responses. In other words, the degree of agreement with the statement in Block 23 varied strongly among the respondents.

Table 13

*Chi-Square Test for Goodness of Fit – Block 23*

| **Block 23** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| | | | | | | | |
| **Actual** | 3 | 6 | 1 | 2 | 4 | 8 | 4 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **8,5** **C = 0.48** $C_{max}$ 0,93
***p*-value 0,2037**

Block 24

The statement in Block 24 of the survey read: "*Training to become an Airline Pilot should significantly vary from Private Pilot Training*".

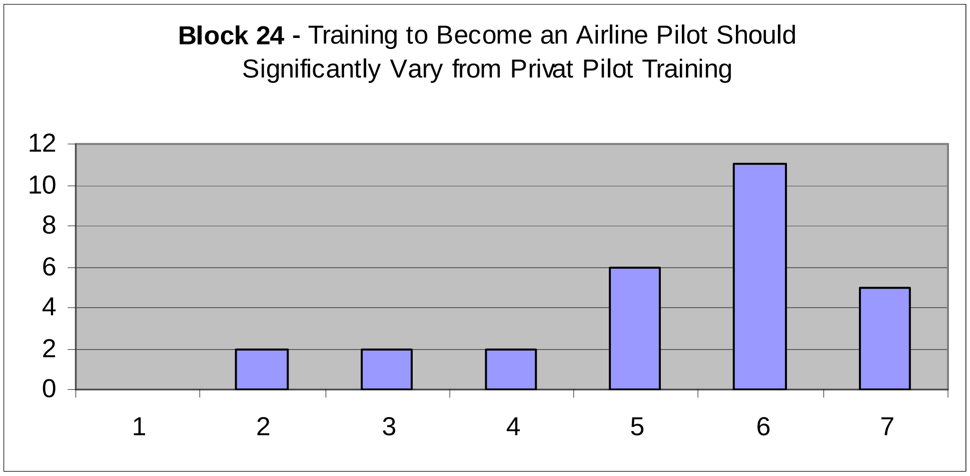


*Figure 11*. Histogram of responses (*1* through *7*) to Block 24 of the Survey.

Dispersion of data was moderate (coefficient of variation of 0.26). The arithmetic means was 5.32 and the mode 6. A fairly high Chi-Square (20.5) and C (0.65) confirm the overall trend of agreement among the respondents. Only four respondents did not agree with the statement and only two were undecided.

Table 14

*Chi-Square Test for Goodness of Fit – Block 24*

| Block 24 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| | | | | | | | |
| **Actual** | 0 | 2 | 2 | 2 | 6 | 11 | 5 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **20,5** **C = 0.65** $C_{max}$ 0,93
***p*-value 0,0023**

Block 25

The statement in Block 25 of the survey read: "*Most of the flight training for an Airline Pilot could be conducted on a flight training/simulation device, rather than on an actual aircraft*."

The histogram of responses (*1* through *7*) can be found on page 59. Dispersion of data was, by far, the greatest with a coefficient of variation of 0.63. The arithmetic means was 2,7 and the moderate Chi-Square of 15,5 (C = 0,6) are indicative of a trend towards disagreement with the statement in Block 25 – however, it must be noted that six respondents did agree to some extent (including one strong and one total agreement) with the statement in Block 25 (which explains the high coefficient of variation).

Table 15

*Chi-Square Test for Goodness of Fit – Block 25*

| Block 25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | | | | | | | |
| **Actual** | 10 | 4 | 6 | 2 | 4 | 1 | 1 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **15,5** **C = 0.60** $C_{max}$ 0,93

***p*-value 0,0167**

Block 26

The statement in Block 22 of the survey read: "*I am familiar with the proposed Multi-Crew Pilot Licence (MPL) Concept*."

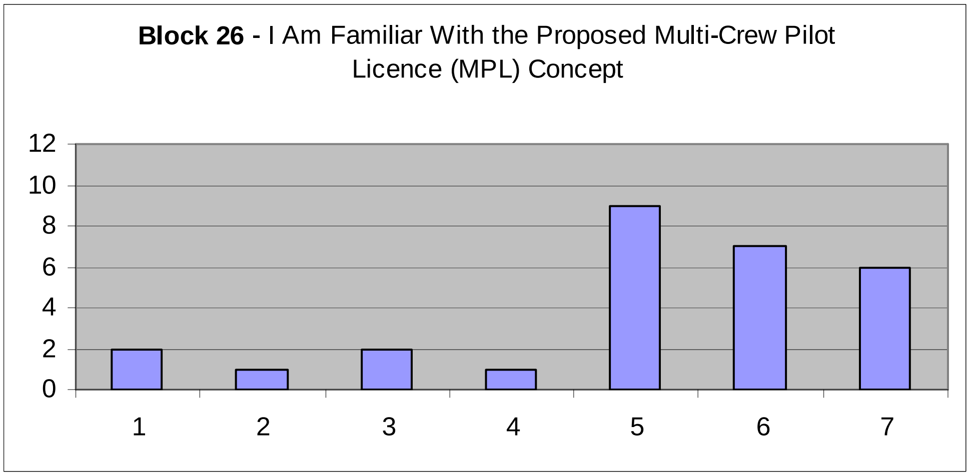


*Figure 12.* Histogram of responses (*1* through *7*) to Block 26 of the Survey.

This statement served more of a "demographic identifier" purpose to be able to distinguish between respondents who were familiar with the MPL-concept and those who were not.  The author already analyzed this in the Chapter "Survey Population" (pp. 50 - 53). Important for this study was the fact that the majority of the respondents had some degree of familiarity with the MPL-concept.

As the data from Block 26 of the survey was not used for analysis per se, no Chi-Square analysis was conducted.

Block 27

The statement in Block 22 of the survey read: "*A well structured Airline Pilot Training program could significantly reduce the total number of flight hours required to reach qualification as an Airline Pilot*."

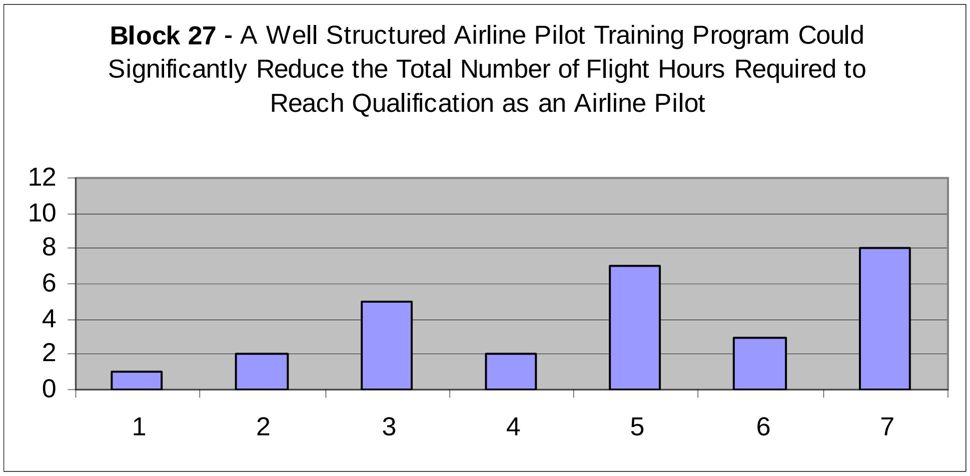


*Figure 13*. Histogram of responses (*1* through *7*) to Block 27 of the Survey.

Dispersion of data was moderate to high (0.37), with an overall tendency towards agreement with the statement in Block 27 (Arithmetic Mean 4.9 – Geometric Mean 4.7). However, there were eight respondents who did not agree and the relatively low values of Chi-Square (11) and C (0.53) were indicative of low consensus among the respondents.

Table 16

*Chi-Square Test for Goodness of Fit – Block 27*

| Block 27 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **OPTION** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| | | | | | | | |
| **Actual** | 1 | 2 | 5 | 2 | 7 | 3 | 8 |
| **Expected** | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

**K = 7**
**df = 6**

$\chi^2$ **11** **C = 0.53** $C_{max}$ 0,93
***p*-value 0,0884**

The results of the survey reflected some of the areas addressed during the "Review of Relevant Literature and Research" (see Chapter II, pp. 16 - 49). In particular, the respondents agreed with the academic community that SFTDs can be a valuable tool in airline pilot training. The respondents also agreed to disagree on exactly how much flight training could – or should – be conducted on SFTDs – mirroring the controversy within the academic community on this subject.

The author also found the fact that the respondents generally agreed that training to become an airline pilot should significantly vary from private pilot training (see "Block 24", p. 81 above) corresponded to the findings in Chapter II. Lee (2002) had elaborated on the differences between *manual flight-skills* versus *cognitive system operator skills* and how the particular training for the respective skills has to be adapted accordingly (i.e. respective degree of functional and physical fidelity) for optimal effectiveness and efficiency of training.

A single-engine, single-pilot, light aircraft (which is what Private Pilots typically fly) requires somewhat more manual skills (→ small aircraft generally have fewer automated systems such as an auto-pilot) and less cognitive skills than a multi-engine, multi-crew, airliner. Consequently, the training for the respective skills-sets that are required should vary accordingly. The answers to Block 24 of the survey showed that the respondents agreed on this variation in training between private pilot and airline pilot training.

The responses to Blocks 23 and 25 of the survey, however, also showed that there was some disagreement among the respondents on exactly how the respective training (Private Pilot versus Airline Pilot) should vary in terms of skills being taught and media (e.g. SFTDs) to be used for training.

About half of the respondents felt that most of the experience gained as a Private Pilot had little value in Airline Pilot training (see “Block 23”, p. 80), while the other half of the respondents felt the opposite. In other words, there was disagreement among the respondents on the value of the predominantly manual flight skills acquired (→Private Pilot) in airline flight operations. This controversy, again, was reflective of the same discussion within the academic community on the “right mix” of manual and cognitive skills required in a modern airline cockpit.

In addition to the question on what the “right skills set” should be the responses to Block 25 and Parts II and IV of the survey also showed some variation in how these skills should be taught (actual aircraft versus SFTD). Similar controversy was found in Chapter II [see Swezey and Andrews (2001) or Allesi and Trollip (1991)].

Potential reasons for the variation in the above assessments were explored in the next chapter. Before going into this discussion of what the reason(s) for the results obtained through this study might be, the author felt that the number of respondents had to be addressed. Obviously, the size of the sample plays an important part in any statistical analysis. In particular, the potential validity of the results per se, as well as the potential reason(s) for the results, are directly affected by this.

The survey population was already analysed in the corresponding Chapter (see pp.50 - 53 of this study). Unfortunately, only 28 valid samples were obtained via the data gathering device. It proved extremely difficult to get responses to the survey. The author has mentioned several times in this paper that Mr Harter of the FCLTP, the participants in the pilot survey and the author worked together in designing the survey.

One of the biggest challenges was trying to keep the complexity and completion time (i.e. time it took a respondent to complete the survey) of the survey to a minimum – while, at the same time, ensuring the questions adequately covered the research. In particular, a certain level of diversity in the training assessment was required to be able to come up with a base-line flight hour requirement.

A somewhat less complex survey might have resulted in more responses; however, the trade-off would have been less diversified data (in particular, on training hour requirements).

In spite of the relatively small number of completed surveys, the author feels confident that the respondents were a representative sample of the flight instructor population. For example, demographic parameters, such as nationalities or training background, were diverse.

Additionally, the fact that there were varying degrees of dispersion in some areas of the training assessment (Part III of the survey) is indicative of a certain disparity between the respondents.

# CHAPTER V

# DISCUSSION

The author believes that when trying to answer the question “why” certain results occurred, it is imperative to look at the “who” of “who” answered the questions – “who” in the sense of the particular attitude(s) of the respondents.

Earlier in this paper, a brief review of the origin of the MPL-concept was given. The ANC of ICAO felt that current flight crew licensing and training standards should be adjusted to account for the fact that modern cockpits and flight operations have become increasingly automated.

The ANC established the FCLTP, which then spent over five years developing the MPL-concept. The FCLTP determined that a CBT-approach to flight training could be a feasible alternative to the existing flight-training programs. The panel further held that the advances in training methodologies, equipment (i.e. SFTDs) and information technology could – and should – be incorporated into such a CBT-program.

There was a lot of controversy within the FCLTP, in particular on the area of how many flight training hours would be a reasonable basis for the CBT-approach. Additionally, there was controversy on how much training could/should be conducted on SFTDs.

A team consisting of the pilot-study participants, Mr Harter and the author (this team is from here-on referred to as the *survey-team*) tried to design the survey to cover as much of the above as possible. To do so, Part III (Blocks 21 – 27) aimed at assessing the survey population’s attitudes towards some of the elemental concerns surrounding the MPL.

## Attitudes of Respondents

In Block 21 of the survey, respondents were asked to give their personal opinion on adequacy of current flight crew training and licensing requirements. As the results show (see Figure 9, p.78), the survey population was almost exactly split in half in this area (twelve respondents disagreed and thirteen respondents agreed to some degree, while three respondents were undecided on the question of whether current requirements were adequate or not).

The author felt it was worth taking a look at the flight hour assessments of those respondents who either agreed or disagreed that current training requirements were adequate. Table 17 is a summary of the results.

Table 17

*Training Hour Assessment by Varying Attitudes towards Adequacy of Current Training*

| **Population** - Statistical Parameter | **Total Training Hours - Part II** | **Total Training Hours - Part IV** | **Training Hours in Actual Aircraft Part II** | **Training Hours in Actual Aircraft Part IV** | **Training Hours in SFTDs - Part II** | **Training Hours in SFTDs - Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **Current Training Adequate** (13 respondents) | | | | | | | | |
| Arith. Mean | 300 | 251 | 207 | 154 | 93 | 97 | 31% | 39% |
| Stand. Deviat. | 100 | 59 | 109 | 61 | 49 | 55 | 16% | 17% |
| Coeff. Of Var. | 0,33 | 0,24 | 0,53 | 0,4 | 0,53 | 0,58 | 0,52 | 0,44 |
| **Current Training Inadequate** (12 respondents) | | | | | | | | |
| Arith. Mean | 288 | 259 | 177 | 130 | 111 | 129 | 39% | 50% |
| Stand. Deviat. | 110 | 103 | 85 | 63 | 52 | 60 | 11% | 15% |
| Coeff. Of Var. | 0,38 | 0,38 | 0,48 | 0,48 | 0,47 | 0,46 | 0,28 | 0,3 |
| **Total Population** | | | | | | | | |
| Arith. Means | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Deviat. | 101 | 81 | 80 | 61 | 74 | 56 | 14% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | 0,39 | 0,36 |

Note. Data on the three *undecided* respondents was not listed separately, but included in the Total Population.

The numbers were fairly close for both groups of respondents - so basically, the overall training hour assessment was not too different, regardless of whether the respondents felt that current training and licensing requirements were adequate or not.

The author did note a few items of interest. In particular, the author found it very intriguing that those respondents who felt current training and licensing requirements were inadequate actually called for fewer total training hours in Part II of the survey (288 versus 300) and only slightly more total training hours in Part IV (259 versus 251).

The data suggests that the respondents who did not agree that current training and licensing procedures are adequate, did not consider this “inadequacy” a result of too few flight-hours, but something else.

Both groups still held that, overall, there should be more training hours on actual aircraft versus SFTDs. However, the respondents who felt current requirements were inadequate, listed fewer training hours on actual aircraft and more training hours on SFTDs than the other respondents, in both, Parts II and IV. Apparently, the respondents who disagreed with the statement in Block 21 believed SFTDs should be utilized to a greater degree. By doing so, the overall training hour requirement might be reduced - in simple terms – quality instead of quantity. (The author wants to emphasize, however, that both groups still called for well over 100 hours of flight training in an actual aircraft in both parts of the survey.)

Blocks 22 – 27 of the survey did not have a “split” distribution of data. In these areas there was either a tendency towards agreement with the statement (Blocks 22, 24, 26 and 27) – disagreement with the statement (Block 25) - or no trend in the observed data (Block 23).

For an analysis into the reasons "why" a particular respondent came up with his/her particular training hour requirement(s) it is helpful to have a distinguishing factor upon which a potential correlation can be based. With the small number of respondents, such correlations were difficult to determine. Nevertheless, the author did perform an analysis of training hour requirements based upon variations in Blocks 25 and 27 of Part III of the survey.

The author picked Blocks 25 and 27, as the overall trend towards disagreement/ agreement was not as strong as in Blocks 22, 24 or 26. In other words, there was a certain number of dissenting opinions in Blocks 25 and 27 (six respondents in Block 25 and eight in Block 27 respectively). Table 18 summarizes the results when separating respondents based upon their assessment of the statement in Block 25.

Table 18

*Training Hour Assessment by Varying Attitudes towards Utilization of SFTDs*

| **Population** - Statistical Parameter | **Total Training Hours - Part II** | **Total Training Hours - Part IV** | **Training Hours in Actual Aircraft - Part II** | **Training Hours in Actual Aircraft - Part IV** | **Training Hours in SFTDs - Part II** | **Training Hours in SFTDs - Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **Most Training not on SFTDs** (20 Respondents) | | | | | | | | |
| Arith. Mean | 292 | 269 | 192 | 163 | 100 | 106 | 34% | 39% |
| Stand. Dev. | 88 | 86 | 73 | 64 | 45 | 49 | 11% | 14% |
| Coeff. Of Var. | 0,3 | 0,32 | 0,38 | 0,39 | 0,45 | 0,46 | 0,32 | 0,36 |
| **Most Training on SFTDs** (6 Respondents) | | | | | | | | |
| Arith. Mean | 279 | 246 | 162 | 99 | 117 | 147 | 42% | 60% |
| Stand. Dev. | 116 | 60 | 112 | 14 | 61 | 68 | 18% | 18% |
| Coeff. Of Var. | 0,42 | 0,24 | 0,69 | 0,14 | 0,52 | 0,46 | 0,43 | 0,3 |
| **Total Population** | | | | | | | | |
| Arithm. Mean | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Dev. | 101 | 81 | 80 | 61 | 74 | 56 | 14% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | 39% | 0,36 |

Note: Data on the two *undecided* respondents were not listed separately; however, their assessment was included in the data on the total population.

The statement in Block 25 read: “Most of the flight training for an Airline Pilot could be conducted on a flight training/simulation device, rather than on an actual aircraft”.

It was not surprising to find that those instructors who agreed with this statement had called for significantly more hours in SFTDs than those instructors who disagreed with the statement.

The author points out, however, that in Part II of the survey the instructors who agreed with the statement in Block 25 did not list more training hours on SFTDs (versus training hours on an actual aircraft). In contrast, in Part IV these instructors had called for more training hours on SFTDs versus hours on actual aircraft. The respective percentages of SFTD-hours of the total hour requirement were 60% (Part IV) and 42% (Part II).

The author found this interesting, as it showed a certain inconsistency in the answers of some respondents. In particular, answers relating to the training assessment (Part III) on the one hand and the training hour requirements (Parts II and IV) of the survey on the other hand.

[NOTE: Review of the specific data showed that the above inconsistency only applied to two respondents. Of the six respondents who had agreed with the statement in Block 25, four had called for more training hours on SFTDs (versus actual aircraft) in both Parts II and IV of the survey. The author was not able to follow up with the respective respondents to determine why there was this inconsistency in their respective assessments of Parts II, III and IV of the survey.]

The statement in Block 27 of the survey read: “A well structured Airline Pilot Training program could significantly reduce the total number of flight hours required to reach qualifications as an Airline Pilot." Table 19 summarizes the resulting training hour requirements when distinguishing between respondents who agreed and those who disagreed with the above statement.

Table 19

*Training Hour Assessment by Varying Attitudes towards Potential for Reducing Total Flight Hour Requirements Depending on Overall Structure of the Training Program*

| **Population** - Statistical Parameter | **Total Training Hours - Part II** | **Total Training Hours - Part IV** | **Training Hours in Actual Aircraft - Part II** | **Training Hours in Actual Aircraft - Part IV** | **Training Hours in SFTDs - Part II** | **Training Hours in SFTDs - Part IV** | **Percentage SFTD-Hours of Total Hours Part II** | **Percentage SFTD-Hours of Total Hours Part IV** |
|---|---|---|---|---|---|---|---|---|
| **Agree with Block 27** (18 Respondents) | | | | | | | | |
| | | | | | | | | |
| Arithm. Mean | 302 | 259 | 188 | 133 | 114 | 126 | 38% | 49% |
| Stand. Deviat. | 106 | 93 | 98 | 57 | 53 | 59 | 14% | 15% |
| Coeff. Of Var. | 0,35 | 0,36 | 0,52 | 0,43 | 0,46 | 0,47 | 0,37 | 0,31 |
| **Disagree With Block 27** (8 Respondents) | | | | | | | | |
| Arithm. Mean | 277 | 241 | 189 | 148 | 88 | 93 | 32% | 38% |
| Stand. Deviat. | 93 | 23 | 92 | 29 | 31 | 32 | 11% | 11% |
| Coeff. Of Var. | 0,34 | 0,1 | 0,49 | 0,2 | 0,35 | 0,34 | 0,34 | 0,29 |
| **Total Population** | | | | | | | | |
| Arithm. Mean | 295 | 258 | 193 | 145 | 102 | 113 | 36% | 44% |
| Stand. Deviat. | 101 | 81 | 80 | 61 | 74 | 56 | 14% | 16% |
| Coeff. Of Var. | 0,34 | 0,31 | 0,53 | 0,42 | 0,69 | 0,5 | 39% | 0,36 |

Note. Data on the two *undecided* respondents was not listed separately; however, their assessment was included in the data on the total population.

The author did not note any significant differences in the assessments of the two groups. Overall, respondents who disagreed with the statement in Block 27 felt slightly fewer training hours were required (this difference was mainly in the area of SFTD-hours, approximately 30 hours).

The author concluded that there was no significant correlation between the assessment of the statement in Block 27 and the respective assessment of training hour requirements.

Both groups listed less total training hours in Part IV versus Part II of the survey. This apparent mismatch between the total training hour requirement assessments in Parts II and IV of the survey was noted on several respondents' assessment in the analysis in Chapter IV.

Of the 26 respondents who completed both Parts II and IV of the survey, five listed more training hours in Part IV versus Part II (the respective differences varied between 5 and 50 total hours) – ten respondents listed less training hours in Part IV versus Part II (the respective differences varied between 10 and 350 total hours) and eleven respondents listed the same training hour requirements in Parts II and IV of the survey.

The above variances warranted further analysis; in particular, analysis on "why" some respondents' assessment had differed.

## Training Hour Requirements in Part II versus Part IV

Of the fifteen respondents who had called for a different overall number of flight training hours in Part II and Part IV of the survey, six had significant variances (50 hours or more). Further analysis of the data from these six respondents revealed that all but one respondent had called for more hours in Part II versus Part IV – with the maximum difference being 350 hours.

Unfortunately, most surveys were submitted anonymously and, consequently, the author was not able to follow-up with all the respective respondents for possible explanations. The author was able to get feedback from some of the respondents who had listed significantly more hours in Part II versus Part IV. The respective respondents stated that they felt the *tasks* listed in Blocks 28-36 of the survey only partially covered what it takes to be qualified as a First Officer in an airline cockpit.

In other words, the hour-requirements these instructors listed in Part IV of the survey were what they felt was required to train the student to proficiency on the tasks listed in Blocks 28-36. However, these instructors believed that there were additional requirements before flight-students could be cleared to enter airline flight training as Co-Pilot Trainees. One of the respondents included this in the “Remarks”-section of the survey, in which the instructor wrote:

*“Prior to entering an Airline I feel it is IMPERATIVE that a pilot should have flown in lighter aircraft e.g.: BE58/C402 etc, SA226/BE1900, C208, etc in various environments e.g. critical airstrips, bad weather, etc where they have to make decisions themselves before entering an airline where they will be constantly supervised, and possibly overridden on decisions. This in the long term will make the pilots better Commanders, and possibly also make it possible for them to become Commanders in a shorter time.”*

The author identified two main reasons for differences in the respondents’ assessment on training hour requirements for the tasks identified in Part IV of the survey, versus the overall training requirements in Part II of the survey – the author refers to these two reasons as the *experience factor* and the *simulator factor*.

## Experience Factor

The task breakdown in Blocks 28-36 was done by the survey-team. The original idea had been to simply list the *core-tasks*, as identified by the FCLTP, in the survey. These core-tasks are:

- Apply Threat & Error Management (TEM)
- Perform Aeroplane ground operations
- Perform Take-off
- Perform Climb

- Perform Cruise
- Perform Descent
- Perform Approach
- Perform Landing
- Perform after-landing & aeroplane post-flight operations

However, the feedback by the participants in the pilot-study was that this breakdown was too basic and the concept of TEM too new and too abstract for most flight instructors.

In the "Definitions of Terms" earlier in this paper TEM was defined as:

"*An overarching safety concept that recognizes the influence of threatening outside factors on human performance in the dynamic work environment. Examples of threats could be adverse weather conditions, stressful ATC activities, airport problems, terrain and traffic awareness, errors in aircraft handling and ground navigation, technical problems and incorrect aircraft configurations*." (Sutton, 2005)

The problem for the survey-team was to find a subdivision of tasks that reflected the core-tasks identified by the FCLTP – and, at the same time, was such that respondents could assess explicit flight hour requirements for the respective tasks. The problem was amplified by the premise of keeping complexity of the survey to a minimum.

The survey-group decided to use a different set of tasks (versus the core-tasks identified by the FCLTP) in the survey. In particular, TEM was taken out and replaced by "Abnormal Situations" (both single-engine and multi-engine) and "Crew Resource Management (CRM)/ Crew Coordination Concept CCC)" instead. The subdivision finally used in Part IV of the survey was as follows:

- Block 28 - Basic Flying (incl. Landing)
- Block 29 - Unusual Attitudes

- Block 30 - Abnormal Situations (e.g. Engine Failure)
- Block 31 - Instrument Flying
- Block 32 - Multi-Engine Basic-Flying
- Block 33 - Multi-Engine Abnormal Situations
- Block 34 - Use of Auto-Pilot Flight-Director
- Block 35 - Use of Flight Management System
- Block 36 – Crew Resource Management/Crew Coordination Concept

The survey-group was aware that the TEM-concept encompasses more than handling of abnormal situations and CRM/CCC, but felt that the subdivision in Part IV was sufficient for the purpose of this study. The survey-group believed that the above subdivision adequately reflected the core-tasks identified by the FCLTP and that the subdivision used in the survey was also more conducive to a differentiated analysis of training hour requirements, as well as an analysis of potential substitution of training hours in actual aircraft by SFTDs.

Additionally, the survey group was confident that Part II of the survey (→ assessment of overall flight hour requirements to reach proficiency as an airline pilot) covered the entire spectrum of training. In other words, if a respondent felt that the tasks listed in Part IV of the survey did not encompass what it takes to be qualified as an airline pilot, there should be a difference in the respective respondent's training hour assessment in Part IV and Part II.

The results of the survey showed that several respondents felt that the tasks listed in Part IV of the survey did not reflect what it takes to be qualified to enter airline training as a co-pilot.

As identified in the quote of one of the respondents (see p. 95 above), "decision making" (in particular, making decisions without the presence of an instructor) was one of the areas some instructors felt was not covered adequately by the task-breakdown in Part IV of the survey. Considering the fact that these instructors' deviations in flight training hours assessments between Parts II and IV were largely in training hours on actual aircraft, the author believes that the respective respondents apparently think it is difficult to gain experience in decision making when trained (mainly) on SFTDs.

The above respondents further held that adequate training in – and experience with – decision making will prove to be valuable in the future development of the student pilots; in particular that *command attitude* and *leadership competency* can be improved by this type of experience.

As "experience" is a key element surrounding the above area of potential controversy among the respondents' flight training hour assessments, the author used the term experience factor.

The experience factor is a possible explanation for negative variations between the assessments in Part II versus Part IV (i.e. more training hours listed in Part II).

Positive variations in flight hour assessment (i.e. more hours listed in Part IV) might suggest that some respondents felt the tasks listed in Part IV cover more than what it takes to be qualified to enter airline training as a co-pilot. Unfortunately, the author was not able to follow-up with any of the respective respondents on this.

Simulator Factor

Several respondents stated in Block 37 ("Remarks") of the survey that they believed there were some limitations to using SFTDs as flight training tools. In particular, these instructors felt that adequate training for visual illusions, real-life (dynamic) Air Traffic Control environment, aerodynamic phenomena and situational awareness could not be accomplished solely on SFTDs.

The above respondents gave two main reasons for this – (1) limitations in fidelity of the SFTDs and (2) psychological frame of mind of the trainee.

In the "Review of the Relevant Literature and Research" (pp.16 – 49), the issue of fidelity had already been addressed. The author showed, among other things, that there continues to be a lot of controversy surrounding the use of SFTDs in flight training among the academic community. In particular, concerning the questions how much training should be conducted on SFTDs and on what type(s) of SFTDs (i.e. how much fidelity).

The issue of the trainees' psychological frame of mind is closely related to fidelity. No matter how "real" the simulation, the students (at least subconsciously) know they are sitting in a simulator. No matter what happens, the students will always walk away alive from the simulator.

In the real aircraft, this is obviously different. Even minor mistakes may prove to be fatal. Removing the real-life hazards from the training was identified as one of the main benefits of simulation. At some point, however, exposure to the real-life hazards becomes unavoidable. In flight training this point is, obviously, when the student flies in a real aircraft.

Similarly to fidelity, there is great controversy within the academic community on how much exposure - and exposure to what types of hazards – is conducive or counter-productive to training.

The author found it not surprising to find similar controversy within the flight instructor community. Variances in the particular respondent's assessment on training hour requirements depended on the respective instructor's personal experience with – and attitude towards SFTDs.

In addition to the variances in flight hour requirements, there were even further variances in the particular types of SFTDs to be used for the respective training tasks (Part IV of the survey). The (low) number of respondents and high diversity of data only allowed for some general conclusions which were already addressed on page 66 in the Chapter IV – Sub-Chapter "Base-Line Flight Hour Requirement" and were summarized in Chapter VI. The analysis on potential reasons "why" there were variations in the particular types of SFTDs follows later in this chapter.

The variances in flight training hour assessments in Parts II and IV of the survey and the disagreement among respondents concerning potential use of SFTDs (i.e.how much training time on SFTDs and what types (I – IV) to use) reflect some of the issues the author explored in the "Review of the Relevant Literature and Research" (pp. 16 – 49). Lee (2002) distinguished between *motor* – *cognitive* – and *attitudinal* learning tasks and emphasized that the degree of physical and functional fidelity of the respective training environment must be varied according to the particular type of learning task.

Command attitude and leadership competency clearly fall into the area of attitudinal learning tasks. Lee found that the required degree of functional and physical fidelity for attitudinal learning tasks was difficult to determine and that more research is required in this area. The results of this study confirm his conclusions, as the variances in training hour assessments and mode of training (actual aircraft ↔ SFTD) are indicative of some controversy on the issue.

The simulator factor also ties into the above, as SFTDs are deemed unsuitable for the training of particular tasks, due to the potential shortcomings of SFTDs in providing the required degree of fidelity (both, functional and physical).

What degrees of fidelity are required - and whether state-of-the-art SFTDs can provide these degrees of fidelity – will have to be explored. The results of this survey showed that there appears to be similar disagreement on this matter as in academic circles. Development of the MPL-concept may lead to further insights into the proper mix of physical- and functional fidelity for the training of attitudinal tasks.

Additionally, MPL-training may foster the overall understanding of simulations and SFTDs – what they can or cannot do. Ultimately, this may result in identifying potential improvements in simulation for flight training.

Concerning this study it was important to note that variations in the flight training hour assessments between Parts II and IV of the survey were due, in part, to the experience- and simulator-factors.

The author determined there was another possible explanation for variances in flight hour assessments between Part II and Part IV of the survey – lack of attention to detail on the part of the respondent. Part II of the survey asked for an *overall* assessment, while Part IV asked for a much more *specific* assessment.

The author believes it is possible that some respondents answered Part II “more from the hip" and spent somewhat more time answering Part IV. The respondents then did not go back in the survey to compare their respective assessments. Such behaviour on the part of the respondents could, in particular, explain minor variances between the respective assessments in Part II and IV of the survey.

Regardless of the reasons for the variances between the data provided in Parts II and IV of the survey, it is imperative to be aware of these variances. The author believes that the apparent differences between respondents' conception of what it takes to be qualified as an airline co-pilot trainee are an important conclusion from this study. To develop a MPL-concept, the particular (core)-tasks must be clearly identified and accepted by the training community, to ensure everyone is "singing from the same sheet of music".

The author further believes that, regardless of whether the subdivision used in Part IV of the survey adequately reflects the core-tasks or not, the issues of the experience-factor and the simulator-factor are important considerations. Arguably, the concept of TEM covers the experience-factor - however, as the pilot-study showed, TEM is not (yet) a universally defined and understood concept.

The question whether or not the core tasks (including TEM) adequately cover the requirements for a Co-Pilot Trainee in a modern airline cockpit was not part of this study. The author does feel it is an important aspect surrounding the proposed MPL. The MPL-concept should be reviewed and, possibly, TEM further defined to include the experience-factor to ensure this is part of the developed a training program.

For the purpose of this study, further analysis of potential reasons for variations in the assessment of flight training hour requirements was done.

Other Reasons for Variations of Training Hour Assessment

In Part IV of this study, the survey-data surrounding flight hour requirements (Part II and IV) was broken down by: nationality (see pp. 68 – 69), ab-initio training experience (see pp. 72 - 73) and overall training experience of the respondents (see pp. 74 - 75).

Some respondents' assessment in Parts II and IV of the survey varied significantly, while others (e.g. German respondents) did not. The author can only speculate on the reasons for this. Perhaps, the German respondents felt the task-breakdown in Part IV of the survey covered adequately training to proficiency on the tasks required for an airline Co-Pilot trainee.

From the analysis by total flight instructor experience (see Table 8, p. 75), it appeared that the more seasoned flight instructors felt the tasks identified in Part IV of the survey did not cover the experience factor, resulting in a significant difference in overall flight training hour requirement between Part II and Part IV of the survey.

Another potential reason for some of the discrepancies between the data in Part II and Part IV of the survey was overlapping training elements in the task-breakdown in Part IV of the survey.

Overlapping Training Elements

Several respondents noted that the training to proficiency for most of the tasks listed in Blocks 28-36 is a continuous process with overlapping elements – making it difficult to break the training down into separate blocks (see Appendix E). Consequently, the allocation of specific training hours to the respective blocks in Part IV of the survey was difficult at best.

This problem had also been identified by the survey-group; again, Mr Harter and the author, tried to make the task-breakdown in Part IV of the survey as conducive to the overall goals of the study as possible – while, at the same time, trying to keep the complexity of the survey to a minimum.

The author believes that the above problem of overlapping training elements also applies to the core-tasks identified by the FCLTP. In particular, the TEM-concept potentially overlaps with virtually all the other core-tasks. Consequently, specific training hour allocation for the respective core-tasks may be difficult to define.

Regardless of what task-breakdown is ultimately used for a MPL-program, the potential for overlapping training elements must be considered by whoever sets up the respective MPL-program.

In summary of the potential reason(s) for variations in flight training hour assessment, the author points out that, for the purpose of this study, it is important to distinguish between the data in Part II and Part IV of the survey. The data in Part II reflects the overall training requirements, while the data in Part IV only cover certain tasks - specifically, tasks identified by the survey-team as representative of the FCLTP's core-tasks.

Additionally, the author has shown that there were a number of potential problems surrounding the data obtained in Part IV of the survey. In particular, these potential problems were: (1) task breakdown (Blocks 28-36) not an exact representation of the core tasks identified by the FCTLP – (2) potential for respondents to feel that the experience factor is not included in the task breakdown in Blocks 28-36 – (3) difference in respondent's attitude towards the simulator factor - (4) difficulty in specific training hour allocation to respective tasks in Blocks 28-36, due to overlapping training elements – (5) wide spectrum of training hour allocation.

The above problems reflected some of the results from the "Review of Relevant Literature and Research" (see pp. 16 – 49). Flying per se is considered a *high performance skill*, making the respective training to become a pilot a complex task. In addition to the basic flying skills required of any pilot (Private or Airline), airline flying adds the elements of a multi-crew environment and systems management requirements to the already complex training. Advances in training methodology (e.g. CBT) and technology (e.g. SFTDs) have opened new possibilities for pilot training – however, also have added potentially more complexity as well.

As the variations in the respondents' assessments surrounding the "experience factor" and the "simulator factor" showed, there appeared to be some disagreement among the survey population on what tasks adequately represent the skills required of an airline co-pilot trainee. This disagreement was reflective of the controversy surrounding the particular "optimum mix" of manual, cognitive, and attitudinal skills mentioned several times in this study. Lee (2002) used the analogy of "hand", "head" and "heart" to signify the different types of skills.

While the above problems had to be kept in mind, the author believes that the data obtained via Parts II and IV of the survey still provided a meaningful basis for the development of a base-line flight training hour requirement.

## Base-Line Flight Hour Requirement Analysis

One of the main goals of this study was to establish a base-line flight training hour requirement, from which to start the iterative process of developing a CBT-program for the MPL. Parts II and IV of the survey aimed at determining such a base-line flight hour requirement, with Part II being an overall assessment and Part IV being a more specific assessment.

There was a wide range of data in Part II and IV of the survey (refer to Table 1, p. 62). The following is a summary of the data:

- **Overall Training Hours**

| **Part II** | **Part IV** |
|---|---|
| Mean = 295 | Mean = 258 |
| Standard Deviation = 101 | Standard Deviation = 81 |
| Hi = 550. Low = 150 | Hi = 550. Low = 99 |

- **Training Hours on Actual Aircraft**

| **Part II** | **Part IV** |
|---|---|
| Mean = 193 | Mean = 145 |
| Standard Deviation = 97 | Standard Deviation = 60 |
| Hi = 445. Low = 98 | Hi = 310. Low = 27 |

- **Training Hours on SFTDs**

| **Part II** | **Part IV** |
|---|---|
| Mean = 102 | Mean = 113 |
| Standard Deviation = 74 | Standard Deviation = 56 |
| Hi = 265. Low = 32 | Hi = 265. Low = 32 |

In Part IV of the survey, the respondents had been asked to give a more detailed breakdown of how many hours of training they felt were required for specific tasks. In Chapter IV of this study the author stated that an ANOVA on the data of Part IV of the survey was conducted (see Appendix D). Table 20 lists a summary of the results for the respective tasks.

Similarly to the overall training hour assessment, there was a wide range in individual flight training hour assessments for the particular tasks. This is most evident when looking at the *Hi* and *Low* values for the respective tasks. The author believes there were similar reasons for the disparities in the task training assessment, as there were in the respondents' assessments on overall training hour requirements in Parts II and IV of the survey. In particular, the author believes that the experience factor and the simulator factor were among the main reasons for the disparities.

With the wide range of individual assessments by the respondents, an obvious question was whether a base-line training hour requirement could be developed from the data at all – and if yes, how to develop it.

Closer analysis of the data has revealed that the wide range of training hour assessments resulted mainly from a few extreme assessments in various areas of the survey. Based on this, the author is confident that, overall, the data can be used to give at least a good approximation of a base-line training hour requirement.

Table 20

*Summary of ANOVA Data of Training Hour Requirements Assessment in Part IV of Survey*

| TASK | TOTAL TRAINING HOURS | | | | | SFTD HOURS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Confidence Interval | Standard Deviation | Hi | Low | Mean | Confidence Interval | Standard Deviation | Hi | Low |
| Basic Flying | 38,5 | 31,64 - 45,29 | 25,6 | 150 | 15 | 4,42 | 0,2 - 8,65 | 7,53 | 25 | 0 |
| Unusual Attitudes | 10 | 3,18 - 16,82 | 5,39 | 20 | 2 | 1,31 | 0 - 5,54 | 2,11 | 5 | 0 |
| Abnormal Situations | 15,3 | 8,52 - 22,17 | 15,8 | 85 | 2 | 4,81 | 0,58 - 9,04 | 7,18 | 30 | 0 |
| Instrument Flying | 84,6 | 77,79 - 91,44 | 28,5 | 150 | 30 | 40 | 35,77 - 44,23 | 20,2 | 100 | 0 |
| Multi-Engine Basic Flying | 20,8 | 13,98 - 27,63 | 14,8 | 60 | 5 | 7,04 | 2,81 - 11,27 | 8,78 | 30 | 0 |
| Multi- Engine Abnormal Situations | 22,6 | 15,79 - 29,44 | 16,8 | 85 | 2 | 10,5 | 6,23 - 14,69 | 7,53 | 30 | 2 |
| Use of Auto-Pilot Flight Director | 17,3 | 10,48 - 24,13 | 16 | 80 | 2 | 11,3 | 7,12 - 15,57 | 12,8 | 60 | 1 |
| Use of FMS | 17,9 | 11,06 - 24,71 | 10 | 50 | 5 | 13,5 | 9,27 - 17,73 | 9,3 | 45 | 0 |
| CRM/CCC | 31,1 | 24,29 - 37,94 | 14,3 | 60 | 10 | 19,7 | 15,46 - 23,92 | 13 | 50 | 0 |

Note. The value for the “Confidence Interval” is based on a 95% confidence interval for the respective mean.

The next question then was how to calculate the base-line requirement from the available data on hand.

One approach towards developing the base-line requirement for the MPL-concept could be to simply take the mean-values of the training assessments in Part II and IV of the survey. With this approach, the respective numbers are:

- Part II - 295 training hours total (193 on actual aircraft and 102 on SFTDs)
- Part IV - 258 training hours total (145 on actual aircraft and 113 on SFTDs)

One problem with simply using mean-values is that extremes may disproportionately skew the overall data. The geometric mean is, perhaps, a better parameter on highly dispersed data. The geometric mean values for the flight hour requirements are:

- Part II – 280 training hours total (175 on actual aircraft and 105 on SFTDs)
- Part IV – 246 training hours total (132 on actual aircraft and 114 on SFTDs)

Regardless of whether the arithmetic or geometric mean is used, another question was which data – data from Part II or Part IV (or a combination of both) – should be used.

The MPL-concept aims at training a student pilot to proficiency to be able to enter airline training as a co-pilot trainee. Part II of the survey asked the respondents for their overall assessment of the required training hours for student pilots to reach this proficiency.

Part IV of the survey, on the other hand, was a more specific assessment of training hour requirements for particular tasks. With this in mind, more weight should be given to the assessments in Part II than to the assessments in Part IV, when developing a base-line requirement, as the goal of the MPL is to train to proficiency to enter airline training as a co-pilot.

Nevertheless, the author believes that the data in Part IV of the survey should also be used for the development of a base-line requirement. First of all, the difference between the data in Part II and Part IV was not too significant (eleven respondents had not listed any differences in training hour requirements between Parts II and IV). Second, the breakdown of training tasks in Part IV provided the option of a more refined base-line requirement, by breaking the base-hour requirement down into several tasks. Finally, the ANOVA-data allows for a more diversified approach towards the base-line-requirement.

In Table 20 above, the 95%-Confidence Interval for the mean for each Task from Part IV is given. Adding the respective low- and high-values of this Interval resulted in a range for the training hours for the entire tasks listed in Part IV. This range was: 197.73 – 319.03 total training hours and 77.44 – 150.64 SFTD-hours.

The final question on which data to use in developing a base-line flight hour requirement was whether some respondents' assessment should be given more weight than others, based upon demographic parameters of the respondents.

In the above calculations, different weight was given solely on the basis of statistical parameters (e.g. extreme deviation) and not based upon demographic parameters (e.g. nationality, training background, training experience, etc.).

The author did conduct in-depth analyses of particular deviations in training hour assessments based upon demographic data earlier in this and the preceding chapter. Some significant deviations in the respective respondents' assessments were noted. For example, *Other* respondents had called for significantly more training hours on actual aircraft than the *German* and *US* respondents.

Arguably, there are reasons to place more weight on certain assessments than on others. For example, one could argue that the assessment by the more experienced instructors should count more than the assessment of the less experienced (→ "more experience = more knowledge"). The counter-argument, however, could be that the more experienced instructors are less open to novel concepts (→"you cannot teach an old dog new tricks").

The author concluded that he was not in the position to use demographic parameters as a basis to place more (or less) emphasis on any respondent's (or group of respondents') assessment. Doing so would have equated to the author passing value judgement on *attitudes* or *concepts* (i.e. the *Other* respondents know more/less about flight training than the *Germans* or *US-Americans*) of certain respondents.

The MPL is a novel concept; thus, there should be the greatest possible input, from as many different sources as possible, in the early development phases. Whether or not, certain survey population's attitudes and/or concepts turn out to be “better”, will be seen as the MPL evolves.

While the author did not use demographic parameters for the development of the base-line flight-hour requirement, he felt it was important to identify certain (potential) correlations between demographic parameters and variations in training hour assessments. Training managers should be aware of these potential correlations, as they may be reflective of certain attitudes and philosophies within a particular socio-cultural environment. These attitudes and philosophies, in-turn, may have to incorporated into the respective MPL-program.

Analysis of potential correlations between demographic parameters and variations in training hour assessments was summarized in the previous chapter and the data may be used by training managers in the future development of MPL-concepts.

The respective respondent's – or group of respondents' – attitudes, philosophies and resulting preference of training venue (actual aircraft versus SFTD), as well as resulting assessment of number of training hours for particular task(s), are related to some of the findings in the “Review of the Relevant Literature and Research” (see pp. 16 – 49). The author already mentioned the controversy surrounding the “optimum mix” of piloting skills in airline operations and this, obviously, translates directly into the base-line training requirement.

Depending on the particular emphasis of the respective respondent (more emphasis on manual versus cognitive or attitudinal skills), the resulting training requirements will differ accordingly. The particular training requirements, and potential use of simulations for this training, will, in-turn, result in different requirements in terms of fidelity (physical and/or functional).

Allessi and Trollip (1991) distinguished between the “Teach About Group” and the “How to do Group”. The training for primarily manual skills typically require a higher degree of physical fidelity (i.e. the simulation should “feel” like the real thing), while primarily cognitive and attitudinal skills require a higher degree of functional fidelity. Nevertheless, all skills do require a certain degree of both, functional and physical fidelity.

Exactly how much and what type of fidelity are required continues to be an area of controversy – reflected in the survey results and Chapter II of this study. As mentioned above, the respective assessment on this will be influenced on the particular background of the person(s) asked to make such an assessment.

Additionally, the respondent’s attitude towards effectiveness and efficiency of a particular SFTD also has to be considered. Orlanski and String (1977) showed that SFTDs save time and money; however, they also showed that there was too little data available on exactly how much time and money could be saved. In particular, they criticized the fact that very little research into the marginal utility of simulations had been conducted. Without such data, assessment of how effective and efficient the use of a SFTD really is becomes very difficult.

The author was not aware of any comparable study to the one conducted by Orlansky and String in 1977. Consequently, there is little to no recent data on the (marginal) utility of the latest generation of SFTDs.

The latest generation of SFTDs has incorporated the advancements in simulation and information technology. There is no doubt that the state-of-the-art SFTDs provide higher degrees of fidelity than SFTDs of the 1970s. However, as Orlansky and String pointed out, higher degrees of fidelity do not necessarily translate to more effectiveness or efficiency of training.

Individuals who believe that higher degrees of fidelity will improve the effectiveness and/or efficiency of training will propagate the use of SFTDs with the highest degrees of fidelity. Individuals who feel differently, on the other hand, may feel lower degrees of fidelity are sufficient and, consequently, favour less advanced SFTDs.

Ultimately, the only test to see how effective a particular SFTD really is can only be done in a highly controlled environment with a sufficiently large control group where different SFTDs can be used simultaneously for the same type of training. Unfortunately, such a controlled environment is very costly in terms of money and other resources. Without adequate research into the potential merits of fidelity, a certain degree of speculation remains. Training managers have to be aware of this when designing their respective training program.

In summary of the above, there were several potential problems in the development of the base-line flight hour requirement(s). These were: (1) what data (or combination of data) from Parts II and/or IV of the survey to use – (2) if and what mean value(s) to use – (3) whether any of the data should count more/less, based upon demographic parameters.

In the next chapter the author's conclusions on the above base-line flight hour requirement, as well as other conclusions from the results and discussion have been summarized.

# CHAPTER VI

# CONCLUSIONS

The author has mentioned throughout this paper that there is a certain degree of controversy surrounding some basic questions on the use of simulation and SFTDs for flight training. The author referred to several scholars [e.g. Blaiwes et.al. (1973), Schneider (1985), Allesi & Trollip (1991) or Swezey & Andrews (2001)] in this context earlier in this paper (see "Review of Relevant Literature and Research", pp. 16 - 49).

One of the more obvious conclusions of this study has been that the above controversy apparently extends to the flight-instructor community as well, as evidenced by the relatively wide array of individual assessments in the survey.

Closer analysis of the data, however, revealed that there were some common trends in the flight-instructors' assessments of the MPL-concept per se – as well as in their view on flight training hour requirements.

The number of respondents to the survey was relatively small (28), which prompted the author to address the question on whether any conclusions could be drawn from such a small sample. All 28 respondents met certain qualification- (i.e. flight instructor) and experience-requirements (i.e. minimum hours of flight instructor experience). Additionally, the survey population was very diverse in terms of demographic parameters (e.g. nationality, training background). Based upon this and the fact that there was diversity in the respondents' respective assessments, the author concluded that some results could be drawn from the survey data.

The author would have been more reluctant to come to the above conclusion, if the respondents had agreed on everything. The fact that they did not agree on everything, and the diverse demographic parameters of the respondents, perhaps, made whatever they did agree on even more significant.

From the data obtained by Part III ("Training Requirements Assessment") of the survey, the following general conclusions on the flight instructors' attitudes towards pilot training could be made.

## Training Requirements Assessment

The survey population was split on whether current flight training and licensing requirements for airline pilots were adequate or not, but almost unanimously agreed that the requirements could be improved.

The most controversy within the survey population centered on the question if most of the flight training for an airline pilot could be conducted on a SFTD versus on actual aircraft. The author found no apparent trend in the overall opinion of the respondents.

Similar disparity of opinions was observed in the area of potential value of experience gained as a Private Pilot for airline flight training. The data suggested a slight trend towards attaching little value to experience gained as a Private Pilot (16 respondents), versus ten respondents who felt such experience was valuable (two respondents were neutral on the matter).

A high degree of disparity was also found with regard to the statement that a well structured airline pilot training program could significantly reduce the total number of flight hours required to reach qualifications as an airline pilot. Eight respondents disagreed with the statement, two were neutral and eighteen agreed – thus, overall there was a slight tendency towards agreement.

There was overall consensus that training to become an airline pilot should significantly vary from Private Pilot Training (only four dissenting- and two neutral opinions).

Finally, most respondents felt that the majority of the flight training to become an airline pilot could not be conducted on SFTDs. The overall agreement, however, was not as strong as above – with six respondents feeling the majority of the flight training could be conducted on SFTDs and two respondents being neutral on the subject.

More detailed conclusions on the potential substitution of flight training hours on actual aircraft by training hours on SFTDs could be drawn from the analysis of the flight training hour assessments.

## Flight Training Hour Assessments

Analogous to the training requirements assessment above, there were relatively large variances in the individual flight training hour assessments by the survey respondents. Overall, the maximum difference in total flight training hours assessment (Part II of the survey) was 350 hours – with the main differences observed in training hours on actual aircraft (maximum difference 347 hours ).

Several respondents provided feedback on the above differences in training hour assessments. These respondents felt that there are certain skills a novice pilot cannot learn adequately in a simulation. Either one of - or a combination of - the following reasons were given for this:

- **lack of fidelity** – simulation does not adequately represent reality [e.g. visual illusion, real world (dynamic) ATC environment, spatial disorientation]

- **psychological** – trainees are, at least subconsciously, aware that they are “only in a simulation” and that there is no physical danger – once in a real aircraft these students will be exposed to stressors they have no experience with

- **simulation limited by the underlying scenario** – somewhat related to "lack of fidelity" and "psychological" above – generally, simulations follow a pre-determined script that is tied into the training syllabus – this syllabus may or may not cover what the pilot will eventually face in the "real world" -- again, the trainee may not have been exposed to several real-life stressors in the simulation

- **instructor generally present during the simulation** – trainees may not receive enough training in decision making and leadership competence [this could be a particular problem with the proposed MPL, where the trainees continue their training as First Officers and, thus, have a Captain/Commander in the cockpit who makes (all) the decisions – the MPL-trained pilots, therefore have no real command experience until they move into the left seat of the cockpit]

The author summarized the above reasons as **simulator factor** and **experience factor**. The simulator factor referring more to the actual shortcomings of the simulation per se (i.e. lack of fidelity, psychological, simulation limited by underlying scenario) – and the experience factor encompassing more the lack of exposure to decision making and leadership competency training. The two – simulator factor and experience factor – are obviously related and there is no clear-cut dividing line between them.

Closer analysis of the data in the survey showed that the variations in flight training hour assessment were greater in Part II [coefficients of variation 0.34 (total hours) – 0.53 (actual aircraft hours) – 0.69 (SFTD hours)] versus Part IV [coefficients of variation 0.31 (total hours) – 0.42 (actual aircraft hours) – 0.5 (SFTD hours)] of the survey.

Part II was an overall assessment of the training hour requirement to train a student pilot to proficiency as an airline co-pilot trainee. Part IV asked for a more specific training hour requirement for certain tasks. In view of the above coefficients of variation, the results of the survey meant the instructors agreed more on the training requirements for the particular tasks than on the overall training requirements to train a student pilot to proficiency to enter airline training as a co-pilot trainee.

The author concluded from the above that it is imperative to clearly define the tasks included in the MPL first, before an actual training hour requirement can be formulated. The author further concluded that the variances within Part II and the variances between Part II and Part IV can, largely, be attributed to the experience factor. As pointed out several times throughout the study, several respondents believed the tasks listed in Part IV of the study did not adequately cover what is required of an airline co-pilot trainee.

The variances within Part IV, though smaller than in Part II – but still significant, were due to a combination of the experience factor and the simulator factor. The author believes that the simulator factor came more into play in Part IV of the survey, as the respondents were asked to give their assessment on the training requirements for particular tasks. Fidelity and psychological issues become more apparent when looking at a particular task, versus an overall training program.

The author found another, potential, reason for the variances between the training hour assessments in Part II and Part IV – lack of attention to detail on the part of the respondent. As Part II of the survey asked for an *overall* assessment, while Part IV asked for a much more *specific* assessment, the author concluded it was possible that some respondents spent somewhat more time answering Part IV versus Part II of the survey. The respective respondents then did not go back in the survey to compare their respective assessments. Such behaviour could, in particular, explain minor variances between the respective assessments in Part II and IV of the survey.

In view of the large variances in training hour assessments, the author conducted a multitude of different statistical analyses (e.g. arithmetic mean, geometric mean, standard deviation, coefficient of variation, ANOVA) of the data. The results of these analyses showed, that despite the large variances in the individual assessments, there were some conclusions that could be drawn from the overall data. (Note: Unless otherwise stated, values and percentages are the arithmetic means.)

- The majority of the respondents (96 % in Part II and 81 % in Part IV of the survey) called for more than 100 training hours on actual aircraft – with the arithmetic/ geometric mean values for the required training hours on actual aircraft being 193/175 (Part II) and 145/132 (Part IV) respectively

- The overall substitution rate of total training hours by SFTD-hours was below 50%, but still relatively high (36 % - Part II and 44% - Part IV)

- The tasks identified to require the most training hours were “Instrument Flying”, “Basic Flying”, “CRM/CCC” and “Multi-Engine Basic Flying”

- The tasks with the highest potential substitution rates of training hours on actual aircraft by training hours on SFTDs were “Use of FMS” (76.7%), “Use of Auto-Pilot/Flight-Director” (64.9%), “CRM/CCC” (64.4%) and “Multi-Engine Abnormal Situations” (52.7%)

- The tasks with the lowest potential substitution rates of training hours on actual aircraft by training hours on SFTDs were “Basic Flying” (11.8%), “Unusual Attitudes” (12.6%), “Abnormal Situations” (31.1%) and “Multi-Engine Basic Flying” (32.8%)

The above conclusions suggest that, concerning the tasks identified in Part IV of the survey, the respondents believed SFTDs could (or, perhaps, should) be used more for the training of predominantly cognitive and attitudinal skills, such as operating a flight management system, using an auto-pilot/flight director or learning to apply CRM/CCC.

Predominantly motor skills (e.g. basic flying or unusual attitudes), on the other hand, should be trained on actual aircraft.

While the individual assessments of potential rates of substitution varied somewhat (see Appendixes B, C and D), the above trend was observed for all respondents. This common trend, and some of the areas of agreement identified in the “Training Requirements

Assessment" earlier in Chapter V, led the author to the following conclusions surrounding a base-line training hour requirement for the proposed MPL.

Base-Line Flight Hour Requirement Conclusions

To determine the base-line flight hour requirement, it was important to recall that some respondents felt the tasks identified in Part IV of the survey did not reflect what it takes to be qualified as a student co-pilot for airline training. In particular, five respondents listed significantly more hours (between 90 and 299 more hours) in Part II versus Part IV, one respondent listed significantly less (100 hours less), eleven respondents called for minor differences (less than 50 hours) in Part II and Part IV and eleven respondents had the same training hour assessments in Part II and Part IV of the survey.

To account for the deviations between Parts II and Part IV, the author determined an overall training hour requirement (based on Part II of the survey) of 280 hours of flight training (the geometric mean was used due to the relatively wide spread of data) and a task-specific training hour requirement (based on Part IV of the survey) of 258 training hours (based on sum of ANOVA mean values).

The 28 hours difference between the overall training hour requirement and the *skills-specific* training hour requirement should cover any potential skills required for the MPL, which were not covered by the tasks identified in Part IV of the survey.

The results of the ANOVA were then applied to determine how the 258 skill- specific training hours should be divided between the respective tasks, and how many (if any) of these hours could be substituted on SFTDs. Table 21 summarizes the results:

Table 21

*Base-Line Requirement for Skill-Specific Tasks from Part IV of Survey*

| TASK | TOTAL TRAINING HOURS | SFTD HOURS |
|---|---|---|
| Basic Flying | 38 | 4 |
| Unusual Attitudes | 10 | 2 |
| Abnormal Situations | 15 | 5 |
| Instrument Flying | 85 | 40 |
| Multi-Engine Basic Flying | 21 | 7 |
| Multi- Engine Abnormal Situations | 23 | 11 |
| Use of Auto-Pilot Flight Director | 17 | 11 |
| Use of FMS | 18 | 14 |
| CRM/CCC | 31 | 20 |
| **TOTAL** | **258** | **114** |

Conducting 114 of the 258 training hours on SFTDs, would leave 144 training hours on actual aircraft – equating to a potential substitution rate of total training hours by SFTD-hours of 44%. While this is on the high end of the respondents' potential rates of substitution, the author needs to point out that 22 hours (difference between the 280-hour total training and the 258-hour task-specific training) of flight training are not included in the 44%.

The author holds that most (if not all) of the above 22 hours would have to be trained on actual aircraft. The major differences between training hour assessments in Part II and Part IV revolved around experience factor issues. As the author has shown throughout the paper, the majority of the respondents felt that SFTDs are not as conducive as actual aircraft in training these types of skills.

Assuming that none of the 22 hours would be trained on SFTDs, results in an overall substitution rate of total training hours by SFTD-hours of 41% (114 of 280 hours).

After formulating the base-line flight training hour requirement, the final area for potential conclusions was what particular types (I – IV) of SFTDs could be used for what types of training surrounding the MPL.

## Type(s) of SFTDs to be Used

The author already pointed out in Chapter III that there was great variance in the respondents' assessment on what particular type of SFTD could be used in the training of the tasks listed in Part IV of the survey.

Considering how basic questions on fidelity and transfer-effectiveness are directly related to the particular type of SFTD, it was no surprise to find that the great variances in the respondents' overall training requirements assessments were also found in the area of what type(s) of SFTDs to use.

The author concluded that the data obtained through the survey were not sufficient to provide a founded recommendation on what type(s) of SFTD to use for the base-line requirement above.  In order to have been able to make any particular conclusions, the author would have had to be able to follow-up on the responses provided to determine why the respective flight instructor had preferred one type of SFTD over the other.  As the author was not able to follow-up with the majority of the respondents, he was unable to conduct this analysis.

Nevertheless, a few basic trends in the data were observed. Most respondents felt a Type III or IV SFTD should be used for CRM- training; while thirteen respondents felt that a Type I or II SFTD would be sufficient for FMS-training.

The responses are reflective of some of the insights in simulation and training the author addressed in the "Review of the Relevant Literature and Research" (see Chapter II, pp. 16 – 49) – i.e. fidelity requirements of the simulation are commensurate with the complexity of the real-world situation that is being simulated. In the context of the MPL this translated into: Learning to program a FMS-computer does not require a *full-motion* Type IV SFTD – instead, a simple Type I *desktop simulator* can be sufficient for this type of training.

In view of Chapters II, III, and the conclusions above, the author finds there is sufficient data and evidence to support Hypothesis 1 and 3, while Hypothesis 2 is not supported.

The author based his conclusions concerning Hypothesis 1 ("That there is general consensus among flight instructors that current flight crew licensing and training procedures could be improved") mainly on the responses to Block 22 of the survey. The respondents showed a very high degree of agreement that current flight training and licensing requirements for Airline Pilots could be improved.

Additionally, the review in Chapter II showed that advancements in training technology and methodology, if applied correctly, could improve the efficiency and effectiveness of airline pilot training. The evolution of the skills required as an airline pilot from predominantly manual flight skills to predominantly cognitive/attitudinal system operator skills require the airline pilot training to be adapted accordingly (i.e. more emphasis on cognitive and attitudinal skills).

Also, the five dominating forces (i.e. safety, environment, competition, flexibility and regulations) identified by Teunissen (1999), himself an airline-pilot, will necessitate a change in airline pilot training if the airline industry wants to deal with these five forces adequately in the future. Teunissen held that one of the best ways to deal with the five forces would be the increased use of SFTDs in airline pilot training.

The above had prompted the author to formulate the second hypothesis ("A significant portion (at least 50%) of the required flight training for the proposed MPL could be conducted on SFTDs"). The results of the survey did not support this hypothesis, as shown in the responses to Block 25 of the survey and in the flight-training hour assessments in Parts II and IV of the survey.

While the respondents did not feel that overall more than 50% of the flight-training hours should be conducted on SFTDs (versus actual aircraft), the respondents did feel that a fair portion (36% - 44%) of the overall training could be conducted on SFTDs. In fact, in Block 37 ("Comments") of the survey, several respondents emphasized the potential advantages of SFTDs over actual aircraft for the training of certain skills. On the other hand, the respondents also emphasized that there was no substitute for training in an actual aircraft for specific skills and competencies – leading to the third hypothesis.

Hypothesis 3 ("The initial flight training requirements for the proposed MPL would require a significant number of flight training hours – at least 100 – to be performed on an actual aircraft") was supported by the survey results – in particular, the responses to Parts II and IV of the survey.

In Part II of the survey, 97% of the respondents – in Part IV 79% of the respondents - called for 100 (or more) training hours on actual aircraft, with the average number of training hours on actual aircraft being 193 and 145 respectively.

A main goals of the MPL-concept is to streamline airline-pilot training into a more integrated, effective and efficient training program. One of the potential problems with the MPL-concept is that training managers may be tempted to emphasize the use of SFTDs, seeing only short-term economic benefits of doing so.

Swezey and Andrews (2001) pointed out the importance of *retention* in training. They identified the most important aspect surrounding retention to be *the degree of original learning*. The MPL-concept is supposed to provide for a training that ensures future airline pilots have the basic flying skills required as an airline co-pilot trainee.

The MPL-concept sees a student-pilot move directly from the MPL-training into airline operations training; therefore, the only time for the students to learn *basic-flying* is during the MPL-phase. The degree of original learning, thus, becomes critical here as the degree to which a student will learn basic flying during the MPL-phase will determine the student's basic flying skills as an airline pilot. Whether such skills can be adequately acquired in SFTDs continues to be heavily debated (see Chapter II). The survey respondents, apparently, had some reservations as the majority called for a significant number of training hours in actual aircraft.

Based upon the above conclusions, the author made a number of recommendations.

# CHAPTER VI

# RECOMMENDATIONS

The author makes the following five recommendations:

(1) – Continue to explore the MPL-concept

(2) – Critically assess the potential benefits of the MPL-training program

(3) – Critically assess the particular tasks which encompass the MPL

(4) – Consider Base-Line Training Requirement

(5) - Cross-Feed Information

## Continue to Explore the MPL-Concept

The first, and perhaps most basic, recommendation is to continue to explore the MPL-concept. While this recommendation may seem a little trivial at first glance, the author believes it is an important result of this study. He found several reasons in support of this recommendation:

- About half of the survey population felt that the current flight training and licensing requirements for airline pilots are inadequate.
- The vast majority (96%) of the respondents agreed that current flight training and licensing requirements for airline pilots could be improved.
- Experts in aviation training recommend changes to existing training programs and/or development of new training programs to account for the changes in the operational environment.

The author explored the third point above in-depth in the review of the relevant literature and refers the reader, in particular, to the recommendations of Capt. Teunisson (1999), who argued that five dominating forces (i.e. safety, environment, competition, flexibility and regulations) will necessitate the increased use of SFTDs in future airline pilot training programs.

The author showed that the MPL-concept is a novel approach towards airline pilot training, aiming at streamlining training by applying a systems-design approach towards developing the MPL-training program – incorporating the advances in training methodology (i.e. CBT) and technology (i.e. state-of-the-art SFTDs). As such, the MPL embodies the increased use of SFTDs Capt. Teunisson referred to.

Exploration of the MPL-concept could provide an excellent platform for research into TERs- and marginal utilities of SFTDs. As the MPL-concept involves an iterative development of an "optimum" (i.e. most effective and efficient) training concept for airline pilots, it lends itself towards assessing TERs and marginal utilities of SFTDs at each iterative step along the way.

Additionally, closely monitoring the students as they progress (or do not progress) in the MPL-program, could give valuable insights into basic training questions – such as, *retention* or *overload*. Both areas are being heavily debated within academic and industry circles (see "Review of Relevant Literature and Research" pp. 16 - 49).

## Critically Assess the Potential Benefits of the MPL-Training Program

Whether or not training managers will decide to offer a MPL-training program through their training organization will, of course, depend on the potential for improved effectiveness and efficiency of the MPL-program compared to existing airline pilot training programs.

Potential improvements in effectiveness and efficiency are directly related to the five dominating forces – safety, environment, competition, flexibility and regulations. Ultimately, however, the “bottom line” will be what managers will look at – in other words: *Will the MPL save money?*

Such money-savings may come in various forms. Increased safety and flexibility, though difficult to quantify, are worth money. Increased protection of the environment may improve the image of the airline, which, in-turn, may translate to higher ticket-sales. Compliance with regulations – or rather non-compliance with regulations – definitely translates into monetary terms.

Competition is probably the most obvious area in which the MPL may save the training organization/airline money. The MPL, potentially, allows for a reduction in overall training hours, combined with the potential of substituting “expensive” training hours (i.e. hours on actual aircraft or Type III/IV SFTDs) with “cheap” training hours (i.e. hours on Type I and II SFTDs).

The author cautions training managers to critically assess (all) the potential benefits of the MPL training program with a mid- to long-term vision. There may be the temptation to look solely at short-term savings in training-hour costs and not look at potential savings (or costs) later in the trainees piloting career.

It is imperative that both, efficiency and effectiveness of the training program(s) are kept in mind and potential benefits other than immediate dollar-savings are considered as well.

With regard to training hour requirements, a short-term vision may result in setting up a training program for the MPL to train students to minimum proficiency on certain tasks – however, these students may end up requiring more training later in airline operations and/or type-rating transitions.

There is also the potential problem that students are being trained to pass examinations, versus being trained to actual proficiency for a piloting career. Training managers must closely monitor their training programs to ensure this does not happen.

The survey-results showed that there was a rather large divergence among the respondents on how many training hours are required to train students to proficiency as an airline co-pilot trainee (Part II of the survey). There was somewhat less divergence on training hour requirements for certain tasks (Part IV). The author held that the results suggested it was easier to define training-hour requirements for specific tasks, than defining the tasks which encompass the MPL in the first place.

The FCLTP defined TEM as one of the major task-areas to be included in the MPL. Comments by the respondents to the pilot-survey were that TEM is a new and abstract concept that needs to be further defined. The author, thus, formulated the third recommendation.

## Critically Assess the Particular Tasks Which Encompass the MPL

In the "Definition of Terms", the author defined CBT as "*an education/training concept that is learner/participant centered and in which the unit of progression is mastery of specific knowledge and skills*".

Two key terms in this context were *skill* and *competency* - skill being a task or group of tasks performed to a specific level of competency or proficiency – and competency being a cluster of related knowledge, skills, and attitudes that correlate with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development.

The MPL is supposed to be a CBT program and, consequently, skills and competencies will have to be defined for the MPL. Once the skills and competencies are defined, particular training tasks must be identified, which encompass the skills and competencies.

The FCLTP identified core competencies for the MPL (see p. 22); however, while some of these core-competencies were quite specific (e.g. perform take-off or perform landing), others were not as specific (e.g. Perform Approach → What type of approach - visual, instrument, radio-navigation?). The more specific the core-competency, the easier it is to formulate training tasks which encompass the skills required for the respective competency.

As mentioned in the sub-chapter on the 2nd recommendation above (see pp. 128 - 129) the FCLTP also identified TEM as a core competency (i.e. “Apply TEM”). The analysis in this study showed that there was some disagreement among the survey population on what tasks adequately reflect the skills and competencies required in proper application of TEM.

As mentioned in Chapter V of this study, the original idea of the author had been to simply use the core-competencies (as identified by the FCLTP) in Part IV of the survey – however, the feedback by the participants of this study prompted the survey-group to change the task-breakdown in Part IV of the survey.

Eleven respondents, apparently, felt that the task-breakdown that was finally used in Part IV of the survey adequately reflected TEM; as these respondents called for the same number of training hours in Part II and Part IV of the survey.

Fifteen respondents, however, had a different flight training-hour assessment in Part II versus Part IV, suggesting that they did not feel the tasks in Part IV adequately reflected the requirements for the MPL.

The disparities in training hour assessments led the author to the conclusion that it is imperative to clearly identify the tasks required for the MPL, because only then can training-hour requirements be assessed adequately.

Does this mean the FCLTP has to change its core-competencies? The author does not think so. As mentioned throughout this study, the training requirements for the MPL were – and continue to be – heavily debated within the FCLTP. The core-competencies and requirements the panel formulated for the MPL are more a "basis" to work off and not a "cut-and-dried" training template.

A fundamental aspect of the MPL-concept is a high degree of managerial freedom in how to set up the MPL training program. The author referred to the Advanced Qualification Program of the FAA and how the FCLTP envisions the MPL to be developed along the same lines. Being too specific in the formulation of core-competencies might stifle training-managers in the realization of their personal vision of a potential MPL program.

On the other hand, the author does believe the FCLTP must ensure all participating parties (i.e. training organizations, training managers, flight instructors, students and regulators) know what the core-competencies entail. This knowledge is a pre-requisite for training managers to be able to identify the specific training tasks they believe adequately reflect the requirements of the MPL.

The base-line requirement developed in this study may prove to be helpful in the process.

## Consider Base-Line Training Requirement

In the "Developmental MPL Training Schedule" (see Figure 2, p. 24), the FCLTP established a minimum of 240 total training hours, with potentially as little as 60 training hours on actual aircraft (equating to a potential substitution rate of total training hours by SFTD-hours of 75%).

As the results of the survey showed, the respondents felt that the above numbers were not sufficient to train a student pilot to proficiency as an airline co-pilot trainee. The overall training hour requirement assessed in Part II of the survey was, on average, 280 hours. The average training hour assessment in Part II of the survey was somewhat less at 258 hours.

The main difference between the minimum requirements established by the FCLTP and the assessment by the survey respondents (both, in Parts II and IV of the survey) was in the number of training hours on actual aircraft. The flight instructors called for significantly more training hours on actual aircraft (144 to 166 hours – equating to a potential substitution rate of total flight hours by SFTD-hours of 41% - 49%).

[Note: The above numbers are mean values. The degree to which SFTDs should – or should not – be used in the proposed MPL was one of the areas with a high degree of variation among the survey population. Potential rates of substitution of total training hours by training hours on SFTDs ranged from 11% to 70%.]

The author believes it is vital that managers keep in mind that the "Developmental MPL Training Schedule" of the FCLTP is only a guideline with **minimum** training hour requirements. The students must be trained to proficiency in the core-competencies, regardless of how many hours of training it takes – that is what CBT means.

Development of the CBT-training program has to be an iterative process, in which the training requirements will have to be developed over time. Consequently, only time will tell what the average training hours will be.

One approach towards the above iterative process could be to start off with the minimum training requirements and hours established by the FCLTP – i.e. 240 total training hours, with 60 training hours on actual aircraft.

The author, however, recommends to start off with the base-line requirement developed in this study – i.e. 280 (258) total training hours, with 144 training hours on actual aircraft. [Note: The two values (280- versus 258 total training-hours) represent the difference between the data from Parts II and IV of the survey – the 280 hours including what the author referred to as the experience factor. Depending on the overall *attitudes* and *philosophy* of the respective training managers, the additional 22 hours of training may be required or not.]

The total training hours may then be allocated to the specific training tasks as identified in Table 21 (p. 122). Alternatively, the respective training organization may choose a different task-breakdown and allocate the hours among those tasks as seen fit.

Concerning the potential use of SFTDs, the author recommends following the guidelines by the FCLTP, as well as consulting the results of this study. It is important that TERs are tracked to ensure the effectiveness and efficiency of the training.

Ideally, a "control group" of students would be trained in a traditional training program parallel to the MPL students. That way, the two training programs could be compared with each other to see if and how the MPL-concept improves effectiveness and efficiency. The author does realize, however, that this is probably cost prohibitive. If at all, only large training organisations will be able to afford to run both training concepts simultaneously.

At a minimum, training organizations engaging in MPL-training should cross-feed as much information as possible amongst each other.

## Cross-Feed Information

The MPL-concept is a new approach towards airline pilot training. The author believes it is reasonable to assume that there will be some problems and set-backs along the way of developing this new licensing and training program – in particular, considering the wide array of opinions on what the skills and competencies of the MPL should be and how these should be trained.

Blaiwes et.al. (1973) emphasized how important it is for all parties involved in pilot training to understand the underlying complexities of the entire training concept, program and process.

In view of the above, the author highly recommends for all parties involved in the development of a MPL-concept to actively seek information exchange with one another. This should help in avoiding “reinventing the wheel” over and over and should also help in accelerating the iterative process of developing training requirements for the MPL.

Ideally, it might even be possible for training organizations to pool their resources to achieve synergies – both in the research and the development of a MPL-concept. Such synergies could also prove to be beneficial when seeking support from the training industry, as a concerted action will generally be more successful than individual actions.

Ultimately, cooperation among training organizations might even lead to the development of new SFTDs based on specific needs identified by the participating parties. In the words of Captain Teunissen (1999): a “development-push by training requirements” versus the current “development-pull by technology” (see p. 41 of this study).

In summary of the above recommendations and the results/conclusions of this study, the author recommends that any training organization that considers developing a MPL-concept should follow these steps in developmental process:

1 Identify and specify the tasks that reflect the core-competencies (involving training managers, flight instructors and regulators in the process)

2 Develop a training syllabus, specifying the total training-hours for each task, with a further breakdown of these hours into training-hours on actual aircraft (including type of aircraft to be used) and into training-hours on SFTDs (including the type of SFTD to be used) – the base-line requirement developed in this study (see Table 21, p. 122) may be used as an aid to develop the training syllabus (analogous to “1” above, training managers, flight instructors and regulators should work together in developing the training syllabus)

3 Assess the available training infrastructure (e.g. number of- and qualifications of instructors, types of- and availability of training aircraft and types of- and availability of SFTDs)

4 Consolidate the information obtained in steps 1 – 3 to determine if the tasks identified in step “1” are adequately covered by the training syllabus developed in step “2” and whether the training can be conducted utilizing the existing infrastructure assessed in step “3” – if the existing infrastructure is deemed inadequate or insufficient, the training organization must either upgrade the infrastructure (e.g. purchase SFTDs or SFTD-time) or change the task-breakdown/training syllabus to fit into the existing training infrastructure

5 Closely monitor training progression to:

5.1 – determine if the tasks that are being trained adequately cover the core-competencies and if the students progress satisfactorily (i.e. adequate retention, no training-overload) – if not, go back to step “1”

5.2 - track TERs whenever SFTDs are utilized (if the TERs are deemed to be too low for the intended task-training, go back to steps “2” and “3”)

5.3 – calculate marginal utilities of SFTDs whenever used (if the marginal utility of a SFTD has been reached, go back to steps “2” and “3” to determine if the specific task-training should be conducted using other training devices (actual aircraft and/or SFTDs)

6 Actively seek information exchange with other training organizations engaging in MPL-training to get as much cross-feed as possible and to continuously improve the training program

The Instructional Systems Design (ISD) approach to training development (see Figure 3, p. 38), or a similar systematic approach, should be used throughout steps 1 – 6 above. The author is confident that the results of this study can assist in steps 1 – 4.

After a training syllabus has been developed, the next challenge will be to find ways to measure student-pilot performance adequately and accurately and to identify minimum performance standards for the successful completion of the MPL. The results of these assessments will show how close – or how far off – the base-line requirements identified in this study were to the actual training requirements.

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**APPENDIX A**

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**APPENDIX B (page 1 of 7)**

**DATA COLLECTION DEVICE**

For items 1 through 12, either **CIRCLE ONE OF THE ANSWERS** provided or **FILL IN THE BLANK**

1. Nationality: ______________

2. Pilot Licence(s) Currently Held (Type & Ratings – if applicable):

   FAR-based ______________________________________________________________________

   JAR-FCL-based ______________________________________________________________________

   Other (please specify licensing authority) ______________________________________________________________________

3. You received your flight training primarily through which of the following?

   Military    Traditional Flight School    Ab-Initio Flight School

4. Total Flight Experience (Hours):

   <300    301-500    501-1000    1001-2000    2001-5000    5001-10000    >10000

5. Total Flight Experience Multi-Engine (Hours):

   <100    101-300    301-500    501-1000    1001-2000    2001-5000    5001-10000    >10000

**APPENDIX B (page 2 of 7)**

6. Total Flight Experience IFR (Hours):

<100    101-300    301-500    501-1000    1001-2000    2001-5000    5001-10000    >10000

7. Type of operation(s) you have primarily conducted (circle appropriate and give approximate number of flight hours)

Military ________    Recreational ________    Instruction________    Corporate________    Airline________

8. Flight Instructor Since: ________

9. Type of Instructor Rating(s) Currently Held:

FAR-based ______________________________________

JAR-FCL-based ______________________________________

Other (please specify) ______________________________________

10. Total Experience as Flight Instructor (Hours):

<100    101-300    301-500    501-1000    1001-2000    2001-5000    5001-10000    >10000

11. Total Hours of Multi-Engine Flight Instruction (if applicable – Hours):

<100    101-300    301-500    501-1000    1001-2000    1001-5000    5001-10000    >10000

12. Total Hours of IFR Flight Instruction (if applicable – Hours):

<100    101-300    301-500    501-1000    1001-2000    1001-5000    5001-10000    >10000

**APPENDIX B (page 3 of 7)**

Some of the following questions relate to different types of flight training/simulation devices – please use the following list to choose the appropriate type of device when asked:

**Type I - E-training and part tasking devices** -lowest level of simulation - typically used to teach individual aircraft systems (e.g. Flight Management System) as a stand-alone unit (not an entire flight deck simulation) - the physical resemblance to the actual cockpit system(s) is often minimal (e.g. actual switches replaced by touch-screen computer systems) – no motion and no visual cues

**Type II – Simulation of generic turbine powered aeroplane**

**Type III – Simulation of multi-engine turbine powered aeroplane with the following features:**

-- Certificated for 2 pilots
-- Enhanced daylight visual system
-- Autopilot, allowing progressive introduction of sophisticated flight environment

**Type IV – Fully equivalent to Level D Full Flight Simulator -** highest level of simulation - typically used for advanced training, bi-annual check flights and Line Oriented Flight Training – exact replica of flight deck compartment – with motion (6-axis) and visual cues

13. Total Experience as Instructor using any type of flight training/simulation device (see list above):

    Circle any type applicable and indicate total time (hours): Type I _____ Type II _____ Type III _____ Type IV______

14. Any Experience as Flight Instructor in Ab-Initio Flight Training – please circle applicable training and enter approximate number of hours of flight instruction you have given: Basic Flying ________ IFR Training________ Multi-Engine Training_____ Crew Coordination Training________ Airline Transition Training________ Type Rating Training________

**APPENDIX B (page 4 of 7)**

15. Approximately, how many total hours of flight instruction do you feel student pilots should have before they are cleared to enter airline flight training as Co-Pilot Trainees? ________

16. How many of these hours in a complex aircraft? ________

17. How many of these hours in a multi-engine aircraft? ________

18. How many of the above hours could be substituted by a Flight Training/Simulation Device and by what type of device [please circle the appropriate type (Type I - IV – see list before No. 13 above) and indicate respective number of hours?

    Total Hours that could be substituted: ________

    By What Type: Type I ________ Type II ________ Type III ________ Type IV ________

19. How many landings should a Student Pilot have performed? ________

20. How many of these landings could be performed in a Type IV Flight Training/Simulation Device? ________

**APPENDIX B (page 5 of 7)**

For statements 21 through 27, **CIRCLE A NUMBER** from 1 to 7 that **BEST DESCRIBES** your opinion or experience.

| Completely Disagree | Strongly Disagree | Disagree | Undecided | Agree | Strongly Agree | Completely Agree |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** |

TRAINING REQUIREMENTS ASSESSMENT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21. The current flight training and licensing requirements for Airline Pilots are adequate. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 22. The current flight training and licensing requirements for Airline Pilots could be improved. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 23. Most of the experience gained as a Private Pilot has little value in Airline flight training. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 24. Training to become an Airline Pilot should significantly vary from Private Pilot Training. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 25. Most of the flight training for an Airline Pilot could be conducted on a flight training/ simulation device, rather than on an actual aircraft. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 26. I am familiar with the proposed Multi-Crew Pilot Licence (MPL) Concept. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 27. A well structured Airline Pilot Training program could significantly reduce the total number of flight hours required to reach qualification as an Airline Pilot. | **1** | **2** | **3** | **4** | **5** | **6** | **7** |

**APPENDIX B (page 6 of 7)**

Please fill in the following items based upon your personal experience as a flight instructor. Assume the student pilot is in a continuous flight training program to a CPL IFR Rating, to be followed immediately by an Airline Training as Co-Pilot Trainee. Fill in the average number of flight hours which are required for a student pilot to perform the respective task adequately and safely. If possible, **INDICATED THE NUMBER OF HOURS OF FLIGHT INSTRUCTION REQUIRED FOR THE SPECIFIC TASK**, as well as the **TOTAL CUMMULATIVE FLIGHT HOURS UP TO THE RESPECTIVE POINT IN TRAINING**. Also **IF YOU FEEL THAT ANY, OR ALL, OF THE RESPECTIVE FLIGHT HOURS REQUIRED FOR THE PARTICULAR TASK COULD BE SUBSTITUTED** in a Flight Training/Simulation Device – please **FILL IN THE NUMBER OF HOURS THAT COULD BE SUBSTITUTED AND WHAT TYPE(S) OF FLIGHT TRAINING/ SIMULATION DEVICE** (Type I - IV – see list before No. 13 above) **COULD BE USED AS A SUBSTITUTE**.

| **TASK** | **AVERAGE TOTAL HOURS OF FLIGHT INSTRUCTION REQUIRED FOR PROFICIENCY (specific task** | **- cumulative)** | **NUMBER OF ACTUAL FLIGHT HOURS THAT COULD BE SUBSTITUTED BY A FLIGHT TRAINING/SIMULATION DEVICE** | **TYPE OF TRAINING/ SIMULATION DEVICE(S) TO BE USED (Type I – IV)** |
|---|---|---|---|---|
| 28. Basic Flying (incl. Landing) | _________ | _________ | _________ | ___________________ |
| 29. Unusual Attitudes (incl. Stall recovery) | _________ | _________ | _________ | ___________________ |
| 30. Abnormal Situations (e.g. Engine Failure) | _________ | _________ | _________ | ___________________ |
| 31. Instrument Flying | _________ | _________ | _________ | ___________________ |
| 32. Multi-Engine Basic-Flying | _________ | _________ | _________ | ___________________ |

**APPENDIX B (page 7 of 7)**

| TASK | AVERAGE TOTAL HOURS OF FLIGHT INSTRUCTION REQUIRED FOR PROFICIENCY (specific task - cumulative) | | NUMBER OF ACTUAL FLIGHT HOURS THAT COULD BE SUBSTITUTED BY A FLIGHT TRAINING/SIMULATION DEVICE | TYPE OF TRAINING/ SIMULATION DEVICE(S) TO BE USED (TYPE I – IV) |
|---|---|---|---|---|
| 33. Multi-Engine Abnormal Situations | ________ | ________ | ________ | __________________ |
| 34. Use of Auto-Pilot Flight-Director | ________ | ________ | ________ | __________________ |
| 35. Use of Flight Management System | ________ | ________ | ________ | __________________ |
| 36. Crew Resource Management/Crew Coordination Concept | ________ | ________ | ________ | __________________ |

37. Comments (Please use this space for any comments or suggestions you may have concerning Commercial Pilot Training):

# APPENDIX D (page 1 of 6)

STATISTICAL ANALYSIS OF TRAINING HOUR REQUIREMENTS

PART II VERSUS PART IV OF SURVEY

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| A/C Hours II | Mean | | 193.11 | 18.301 |
| | 95% Confidence Interval for Mean | Lower Bound | 155.56 | |
| | | Upper Bound | 230.66 | |
| | 5% Trimmed Mean | | 184.76 | |
| | Median | | 162.00 | |
| | Variance | | 9377.507 | |
| | Std. Deviation | | 96.838 | |
| | Minimum | | 98 | |
| | Maximum | | 445 | |
| | Range | | 347 | |
| | Interquartile Range | | 71 | |
| | Skewness | | 1.555 | .441 |
| | Kurtosis | | 1.671 | .858 |
| A/C Hours IV | Mean | | 145.61 | 11.282 |
| | 95% Confidence Interval for Mean | Lower Bound | 122.46 | |
| | | Upper Bound | 168.76 | |
| | 5% Trimmed Mean | | 142.70 | |
| | Median | | 145.50 | |
| | Variance | | 3563.729 | |
| | Std. Deviation | | 59.697 | |
| | Minimum | | 27 | |
| | Maximum | | 310 | |
| | Range | | 283 | |
| | Interquartile Range | | 76 | |
| | Skewness | | .914 | .441 |
| | Kurtosis | | 1.746 | .858 |

**Percentiles**

| | | Percentiles | | | | |
|---|---|---|---|---|---|---|
| | | 5 | 10 | 25 | 50 | 75 |
| Weighted Average(Definition 1) | A/C Hours II | 98.90 | 100.00 | 128.75 | 162.00 | 200.00 |
| | A/C Hours IV | 48.60 | 84.00 | 106.50 | 145.50 | 182.75 |
| Tukey's Hinges | A/C Hours II | | | 132.50 | 162.00 | 200.00 |
| | A/C Hours IV | | | 108.00 | 145.50 | 176.50 |

**APPENDIX D (page 2 of 6)**

**Percentiles**

| | | Percentiles | |
|---|---|---|---|
| | | 90 | 95 |
| Weighted Average(Definition 1) | A/C Hours II | 411.00 | 433.75 |
| | A/C Hours IV | 208.50 | 298.75 |
| Tukey's Hinges | A/C Hours II | | |
| | A/C Hours IV | | |

**Extreme Values**

| | | | Case Number | Value |
|---|---|---|---|---|
| A/C Hours II | Highest | 1 | 19 | 445 |
| | | 2 | 27 | 420 |
| | | 3 | 28 | 410 |
| | | 4 | 16 | 310 |
| | | 5 | 23 | 285 |
| | Lowest | 1 | 9 | 98 |
| | | 2 | 10 | 100 |
| | | 3 | 6 | 100 |
| | | 4 | 5 | 100 |
| | | 5 | 2 | 118 |
| A/C Hours IV | Highest | 1 | 16 | 310 |
| | | 2 | 23 | 285 |
| | | 3 | 20 | 200 |
| | | 4 | 22 | 197 |
| | | 5 | 25 | 195 |
| | Lowest | 1 | 7 | 27 |
| | | 2 | 5 | 75 |
| | | 3 | 15 | 85 |
| | | 4 | 6 | 89 |
| | | 5 | 19 | 95 |

**Tests of Normality**

| | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| A/C Hours II | .257 | 28 | .000 | .799 | 28 | .000 |
| A/C Hours IV | .129 | 28 | .200* | .933 | 28 | .075 |

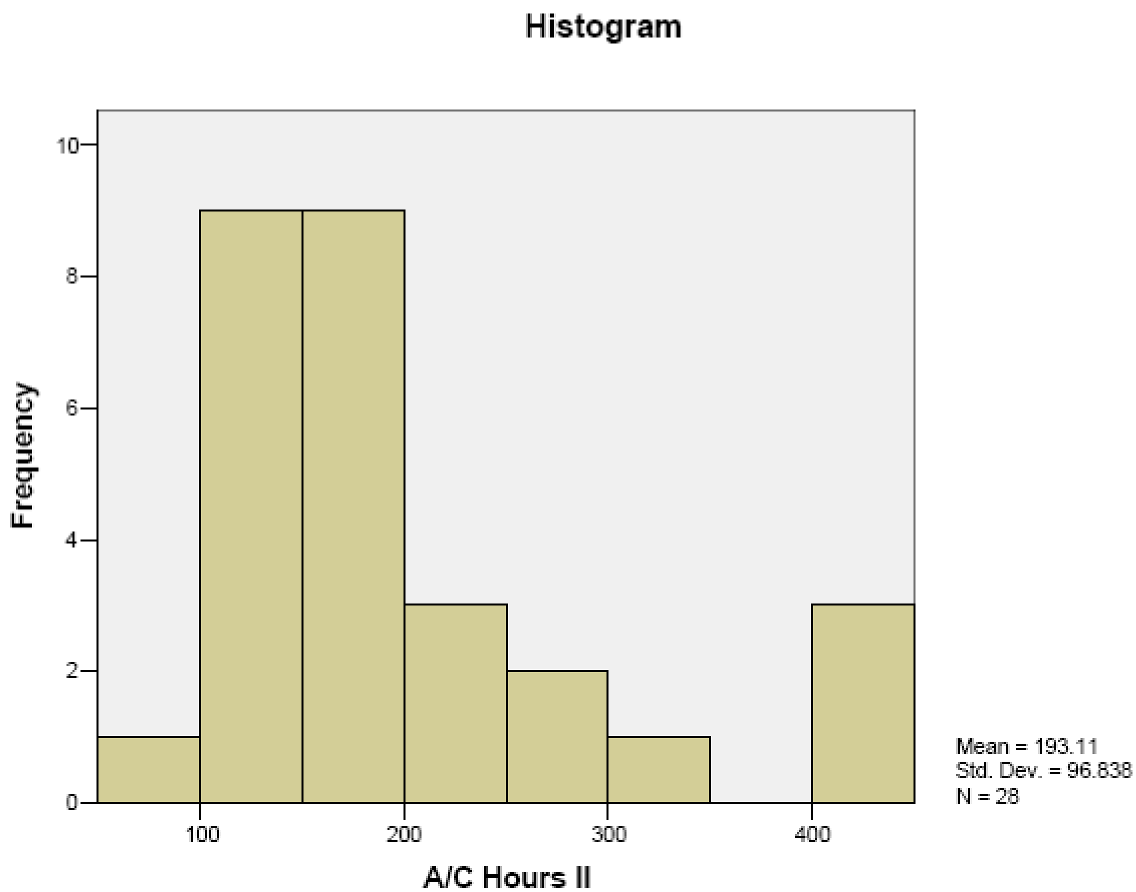
*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

NOTE: To make the Test of Normality more transparent, the author “filled in” data for the two respondents who had not completed Part IV of the survey. The author used the original average of the 26 respondents (145 hours) for the two respondents.

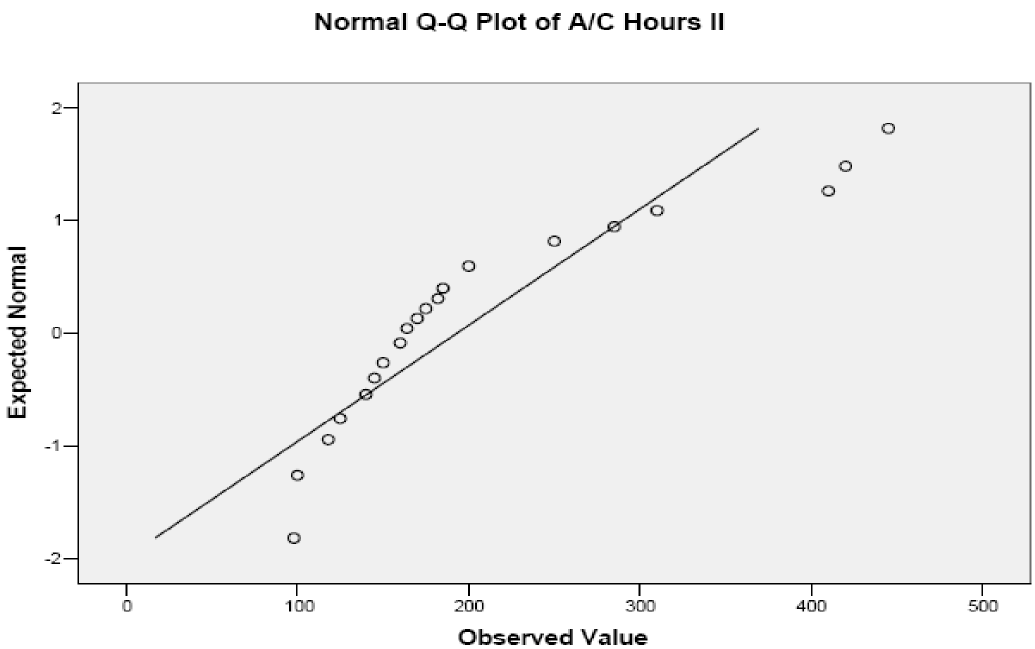
**APPENDIX D (page 3 of 6)**

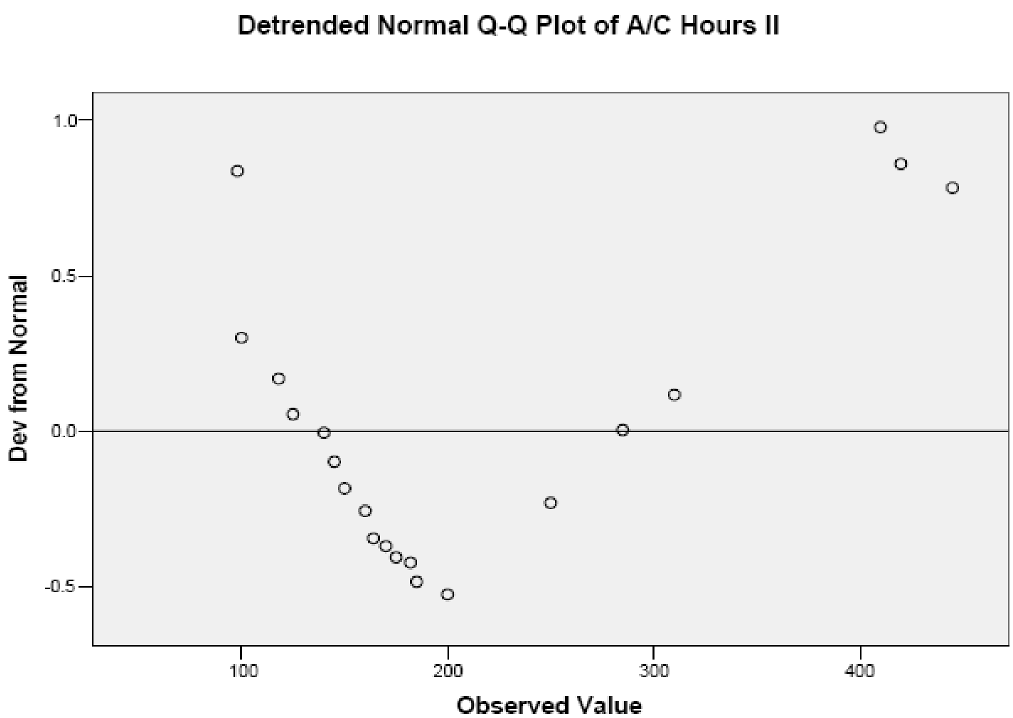
**AIRCRAFT HOURS II**




```
A/C Hours II Stem-and-Leaf Plot

 Frequency    Stem &  Leaf

     1.00        0 .  9
     9.00        1 .  000122444
     9.00        1 .  556667788
     3.00        2 .  000
     2.00        2 .  58
     4.00 Extremes    (>=310)

 Stem width:      100
 Each leaf:       1 case(s)
```

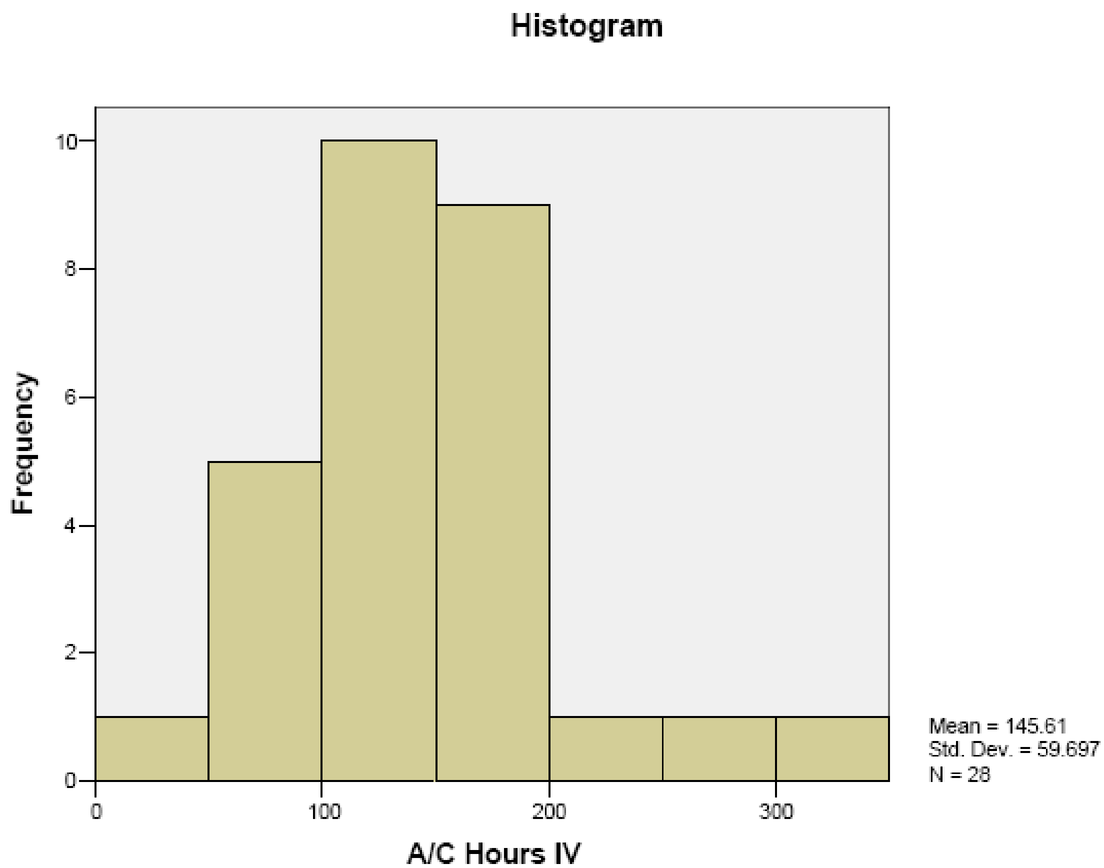
**APPENDIX D (page 4 of 6)**



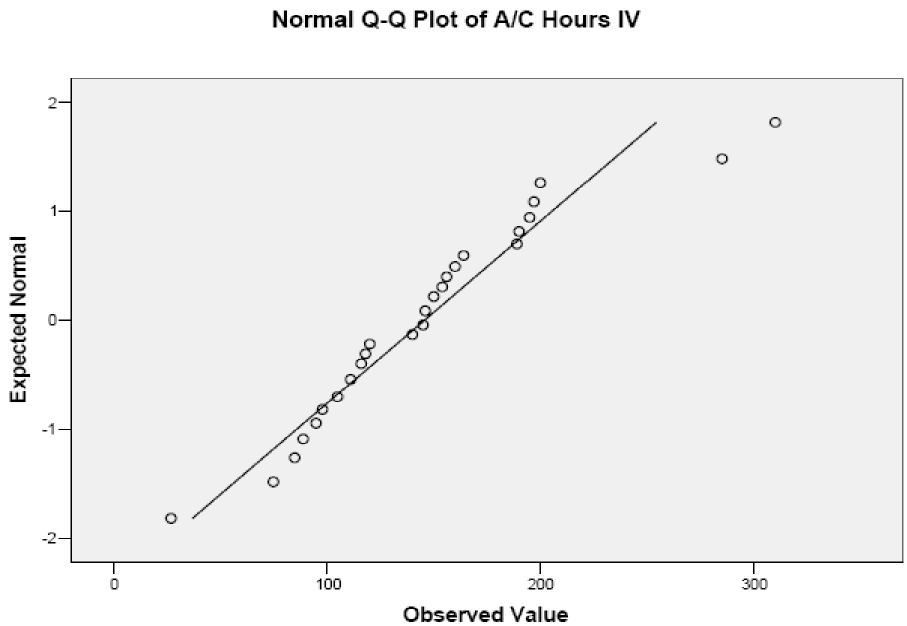
**APPENDIX D (page 5 of 6)**

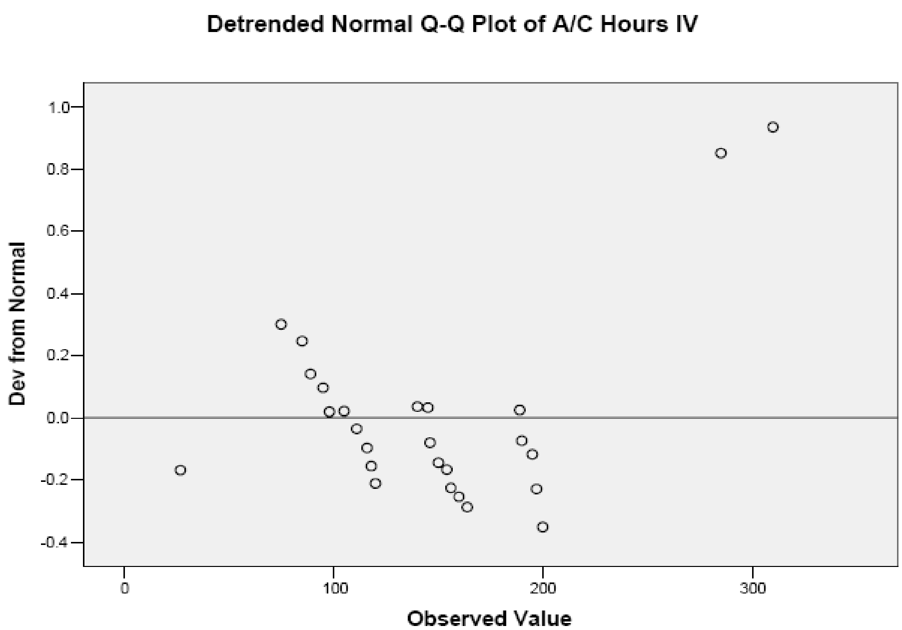
## <u>AIRCRAFT HOURS IV</u>




```
A/C Hours IV Stem-and-Leaf Plot

 Frequency    Stem &  Leaf

     1.00        0 .  2
     5.00        0 .  78899
    10.00        1 .  0111124444
     9.00        1 .  555668999
     1.00        2 .  0
     2.00 Extremes    (>=285)

 Stem width:       100
 Each leaf:       1 case(s)
```

**APPENDIX D (page 6 of 6)**



**APPENDIX E (page 1 of 10)**

RESULTS OF ANOVA OF DATA FROM PART IV OF SURVEY

**ANOVA: Results – Flight Training Assessment – Total Hours**

The results of a ANOVA statistical test performed at 11:35 on 16-AUG-2006

| Source of Variation | Sum of Squares | d.f. | Mean Squares | F |
|---|---|---|---|---|
| between | 1.0665E+05 | 8 | 1.3331E+04 | 42.76 |
| error | 7.0150E+04 | 225 | 311.8 | |
| total | 1.7679E+05 | 233 | | |

---

Basic Flying - Number of items= 26
15.0 15.0 20.0 20.0 20.0 25.0 25.0 25.0 30.0 30.0 30.0 35.0 35.0 35.0 35.0 35.0 40.0 40.0 40.0 40.0 50.0 50.0 50.0 50.0 60.0 150.

Mean = 38.5
95% confidence interval for Mean: 31.64 thru 45.29
Standard Deviation = 25.6
Hi = 150. Low = 15.0
Median = 35.0
Average Absolute Deviation from Median = 13.5

---

Unusual Attitudes - Number of items= 26
2.00 2.00 3.00 3.00 5.00 5.00 5.00 5.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0

Mean = 10.0
95% confidence interval for Mean: 3.176 thru 16.82
Standard Deviation = 5.39
Hi = 20.0 Low = 2.00
Median = 10.0
Average Absolute Deviation from Median = 3.85

---

**APPENDIX E (page 2 of 10)**

Abnormal Situations - Number of items= 26
2.00 3.00 3.00 5.00 5.00 6.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0 25.0 30.0 85.0

Mean = 15.3
95% confidence interval for Mean: 8.523 thru 22.17
Standard Deviation = 15.8
Hi = 85.0 Low = 2.00
Median = 12.5
Average Absolute Deviation from Median = 8.12

---

Instrument Flying - Number of items= 26
30.0 35.0 40.0 50.0 50.0 50.0 50.0 80.0 85.0 90.0 90.0 90.0 95.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 115. 150.

Mean = 84.6
95% confidence interval for Mean: 77.79 thru 91.44
Standard Deviation = 28.5
Hi = 150. Low = 30.0
Median = 97.5
Average Absolute Deviation from Median = 20.4

---

Multi-Engine Basic Flying - Number of items= 26
5.00 5.00 5.00 6.00 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 20.0 20.0 20.0 20.0 20.0 20.0 20.0 25.0 30.0 30.0 40.0 50.0 50.0 60.0

Mean = 20.8
95% confidence interval for Mean: 13.98 thru 27.63
Standard Deviation = 14.8
Hi = 60.0 Low = 5.00
Median = 20.0
Average Absolute Deviation from Median = 10.3

---

**APPENDIX E (page 3 of 10)**

Multi-Engine Abnormal Situations - Number of items= 26
2.00 6.00 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0 20.0 25.0 25.0 25.0 30.0 30.0 30.0 35.0 40.0 50.0 85.0

Mean = 22.6
95% confidence interval for Mean: 15.79 thru 29.44
Standard Deviation = 16.8
Hi = 85.0 Low = 2.00
Median = 20.0
Average Absolute Deviation from Median = 10.8

---

Auto-Pilot/Flight-Director - Number of items= 26
2.00 5.00 5.00 7.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 16.0 20.0 20.0 20.0 20.0 25.0 30.0 50.0 80.0

Mean = 17.3
95% confidence interval for Mean: 10.48 thru 24.13
Standard Deviation = 16.0
Hi = 80.0 Low = 2.00
Median = 12.5
Average Absolute Deviation from Median = 8.92

---

FMS - Number of items= 26
5.00 5.00 5.00 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0 20.0 20.0 20.0 20.0 25.0 25.0 30.0 30.0 30.0 50.0

Mean = 17.9
95% confidence interval for Mean: 11.06 thru 24.71
Standard Deviation = 10.0
Hi = 50.0 Low = 5.00
Median = 17.5
Average Absolute Deviation from Median = 7.50

---

**APPENDIX E (page 4 of 10)**

CRM - Number of items= 26
10.0 15.0 15.0 20.0 20.0 20.0 20.0 20.0 20.0 24.0 25.0 25.0 25.0 30.0 30.0 30.0 30.0 30.0 40.0 40.0 50.0 50.0 50.0 50.0 60.0 60.0

Mean = 31.1
95% confidence interval for Mean: 24.29 thru 37.94
Standard Deviation = 14.3
Hi = 60.0 Low = 10.0
Median = 27.5
Average Absolute Deviation from Median = 11.2

---

**ANOVA: Results – Flight Trainig Assessment – SFTD Hours**

The results of a ANOVA statistical test performed at 04:23 on 11-AUG-2006

| Source of Variation | Sum of Squares | d.f. | Mean Squares | F |
|---|---|---|---|---|
| between | 2.8443E+04 | 8 | 3555. | 29.70 |
| error | 2.6933E+04 | 225 | 119.7 | |
| total | 5.5376E+04 | 233 | | |

---

Basic Flying - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.00 5.00 5.00 10.0 10.0 15.0 20.0 20.0 25.0

Mean = 4.42
95% confidence interval for Mean: 0.1950 thru 8.651
Standard Deviation = 7.53
Hi = 25.0 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 4.42

---

**APPENDIX E (page 5 of 10)**

Unusual Attitudes - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 1.00 1.00 2.00 5.00 5.00 5.00 5.00 5.00 5.00

Mean = 1.31
95% confidence interval for Mean: -2.920 thru 5.536
Standard Deviation = 2.11
Hi = 5.00 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 1.31

---

Abnormal Situations - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 2.00 2.00 3.00 3.00 5.00 5.00 5.00 5.00 5.00 7.00 8.00 10.0
15.0 20.0 30.0

Mean = 4.81
95% confidence interval for Mean: 0.5796 thru 9.036
Standard Deviation = 7.18
Hi = 30.0 Low = 0.000E+00
Median = 2.50
Average Absolute Deviation from Median = 4.50

---

Instrument Flying - Number of items= 26
0.000E+00 10.0 15.0 15.0 25.0 25.0 30.0 30.0 30.0 30.0 40.0 40.0 40.0 40.0 45.0 45.0 50.0
50.0 50.0 50.0 50.0 50.0 50.0 60.0 70.0 100.

Mean = 40.0
95% confidence interval for Mean: 35.77 thru 44.23
Standard Deviation = 20.2
Hi = 100. Low = 0.000E+00
Median = 40.0
Average Absolute Deviation from Median = 14.6

---

**APPENDIX E (page 6 of 10)**

Multi-Engine Basic Flying - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 2.00 4.00 5.00 5.00 5.00 5.00 6.00 6.00 10.0 10.0 10.0 20.0 20.0 20.0 25.0 30.0

Mean = 7.04
95% confidence interval for Mean: 2.810 thru 11.27
Standard Deviation = 8.78
Hi = 30.0 Low = 0.000E+00
Median = 5.00
Average Absolute Deviation from Median = 6.19

---

Multi-Engine Abnormal Situations - Number of items= 26
2.00 4.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00 5.00 6.00 8.00 10.0 10.0 10.0 10.0 10.0 12.0 15.0 15.0 15.0 20.0 20.0 30.0 30.0

Mean = 10.5
95% confidence interval for Mean: 6.233 thru 14.69
Standard Deviation = 7.53
Hi = 30.0 Low = 2.00
Median = 9.00
Average Absolute Deviation from Median = 5.46

---

Use of Auto-Pilot/Flight Director - Number of items= 26
1.00 2.00 3.00 5.00 5.00 5.00 5.00 5.00 5.00 7.00 7.00 8.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 12.0 15.0 15.0 45.0 60.0

Mean = 11.3
95% confidence interval for Mean: 7.118 thru 15.57
Standard Deviation = 12.8
Hi = 60.0 Low = 1.00
Median = 10.0
Average Absolute Deviation from Median = 6.12

---

**APPENDIX E (page 7 of 10)**

Use of Flight Management System - Number of items= 26
0.000E+00 5.00 5.00 5.00 5.00 8.00 8.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0 25.0 30.0 45.0

Mean = 13.5
95% confidence interval for Mean: 9.272 thru 17.73
Standard Deviation = 9.30
Hi = 45.0 Low = 0.000E+00
Median = 10.0
Average Absolute Deviation from Median = 6.12

---

Crew Resource Management/Crew Coordination Concept - Number of items= 26
0.000E+00 8.00 10.0 10.0 10.0 10.0 10.0 10.0 10.0 15.0 15.0 15.0 15.0 15.0 20.0 20.0 20.0 20.0 24.0 25.0 25.0 25.0 30.0 50.0 50.0 50.0

Mean = 19.7
95% confidence interval for Mean: 15.46 thru 23.92
Standard Deviation = 13.0
Hi = 50.0 Low = 0.000E+00
Median = 15.0
Average Absolute Deviation from Median = 9.08

---

**ANOVA: Results – Percent Substitution SFTDs**

The results of a ANOVA statistical test performed at 12:21 on 16-AUG-2006

| Source of Variation | Sum of Squares | d.f. | Mean Squares | F |
|---|---|---|---|---|
| between | 1.1458E+05 | 8 | 1.4323E+04 | 19.85 |
| error | 1.6234E+05 | 225 | 721.5 | |
| total | 2.7693E+05 | 233 | | |

---

**APPENDIX E (page 8 of 10)**

Basic Flying - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10.0 13.0 17.0 29.0 40.0 50.0 50.0 50.0 50.0

Mean = 11.9
95% confidence interval for Mean: 1.504 thru 22.27
Standard Deviation = 19.3
Hi = 50.0 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 11.9

---

Unusual Attitudes - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10.0 20.0 25.0 33.0 40.0 50.0 50.0 50.0 50.0

Mean = 12.6
95% confidence interval for Mean: 2.235 thru 23.00
Standard Deviation = 19.7
Hi = 50.0 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 12.6

---

Abnormal Situations - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 20.0 20.0 25.0 33.0 33.0 35.0 47.0 50.0 50.0 53.0 67.0 67.0 75.0 100. 100.

Mean = 29.8
95% confidence interval for Mean: 19.43 thru 40.19
Standard Deviation = 32.5
Hi = 100. Low = 0.000E+00
Median = 22.5
Average Absolute Deviation from Median = 26.7

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**APPENDIX E (page 9 of 10)**

Instrument Flying - Number of items= 26
0.000E+00 13.0 15.0 17.0 30.0 30.0 40.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 52.0 59.0 60.0 67.0 70.0 80.0 100. 100.

Mean = 49.3
95% confidence interval for Mean: 38.97 thru 59.73
Standard Deviation = 23.5
Hi = 100. Low = 0.000E+00
Median = 50.0
Average Absolute Deviation from Median = 15.1

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Multi-Engine Basic Flying - Number of items= 26
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 17.0 20.0 33.0 33.0 40.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 60.0 100. 100. 100.

Mean = 32.8
95% confidence interval for Mean: 22.43 thru 43.19
Standard Deviation = 33.2
Hi = 100. Low = 0.000E+00
Median = 33.0
Average Absolute Deviation from Median = 27.4

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Multi-Engine Abnormal Situations - Number of items= 26
10.0 20.0 25.0 33.0 33.0 33.0 33.0 35.0 40.0 40.0 43.0 48.0 50.0 50.0 50.0 50.0 50.0 50.0 53.0 67.0 75.0 100. 100. 100. 100. 100.

Mean = 53.4
95% confidence interval for Mean: 43.00 thru 63.77
Standard Deviation = 26.7
Hi = 100. Low = 10.0
Median = 50.0
Average Absolute Deviation from Median = 19.3

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**APPENDIX E (page 10 of 10)**

Auto-Pilot/Flight-Director - Number of items= 26
10.0 47.0 48.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 53.0 60.0 63.0 67.0 67.0 75.0 75.0 90.0 100. 100. 100. 100. 100. 100.

Mean = 65.6
95% confidence interval for Mean: 55.20 thru 75.96
Standard Deviation = 23.7
Hi = 100. Low = 10.0
Median = 56.5
Average Absolute Deviation from Median = 18.8

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FMS - Number of items= 26
0.000E+00 50.0 50.0 50.0 50.0 50.0 50.0 53.0 53.0 67.0 75.0 75.0 80.0 90.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 76.7
95% confidence interval for Mean: 66.27 thru 87.03
Standard Deviation = 26.9
Hi = 100. Low = 0.000E+00
Median = 85.0
Average Absolute Deviation from Median = 22.6

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CRM - Number of items= 26
0.000E+00 25.0 25.0 25.0 33.0 40.0 40.0 50.0 50.0 50.0 50.0 50.0 50.0 50.0 53.0 83.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 64.4
95% confidence interval for Mean: 54.00 thru 74.77
Standard Deviation = 32.0
Hi = 100. Low = 0.000E+00
Median = 50.0
Average Absolute Deviation from Median = 26.8

**APPENDIX F (page 1 of 3)**

COMMENTS BY SURVEY RESPODENTS

09.04.-06:59 - *Kein Flugsimulator ist in der Lage einem angehenden Piloten Feingefühl/Basic Flying so zu vermitteln wie das momental (sic) im Actual Aircraft vermittelt werden kann. Situationsbewusstsein der Cockpit-Crew kann im Simulator zwar trainiert und erweitert werden, doch die Einflüsse im Real Aircraft werden nicht simuliert. Hierzu gehören unter anderem: visual illusions, real-life ATC, aerodynamic phenomena.*
*To gain experience in Abnormal Situations and Memory Actions, the simulator is an excellent tool.*

TRANSLATION: No flight-simulator is capable of teaching a student-pilot fine-feeling/basic flying as the actual aircraft can do this at the present. Situational awareness of the cockpit crew can be trained and fostered in a simulator, but the influences to the real aircraft are not simulated. Among others, these influences are: visual illusions, real-life ATC, aerodynamic phenomena. To gain experience in Abnormal Situations and Memory Actions, the simulator is an excellent tool.

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09.04.-15:21 - MPL (MULTI PILOT LICENCE) RECOMMENDED WITH HIGH PERFORMANCE AIRCRAFT AND TYPE IV SIMULATOR

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11.04.-06:05 - NOTHING CAN SUBSTITUTE ACTUAL FLYING TO GAIN PROFICIENCY IN AIRMANSHIP, SITUATIONAL AWARENESS, WORK-LOAD MANAGEMENT, LEADERSHIP & DECISION MAKING - EXCEPT ACTUAL FLYING! FULL FLIGHT SIMULATORS ARE AN EXCELLENT TOOL TO GAIN EXPERIENCE IN ABNORMAL HANDLING AND PRACTICE LOW-VISIBILITY PROCEDURES; BUT NOTHING MORE; SINCE AERODYNAMIC PHENOMENA, VISUAL ILLUSIONS & DYNAMIC ATC ENVIRONMENTAL SITUATIONS ARE ONLY LIMITED PRESENTABLE AND THE HARDEST FACT IS ALWAYS: YOU ARE STILL SITTING IN A SIM (ON GROUND PSYCHOLOGICALLY)!

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11.04.-18:32 - Navigation needs to be put in somewhere--maybe you intended it go into basic flying or instrument.

Questions are such that you will find inconsistencies between sets of questions.

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20.04.-02:56 - Column 4 varies greatly if the simulator is Type IV as opposed to Type I. I assumed varied simulators. I believe there is value in traditional training BUT that times have changed and that a newer model of training shouldn't automatically throw out all of the concepts and practices of traditional training. Most pilots (career airline or coporate (sic)) still fly recreationally and any new concept of training should enhance, not limit their potential.

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**APPENDIX F (page 2 of 3)**

04.05.-08:19 - My background is somewhat mixed. I am a flight instructor but I also have 2500 hours as a navigator, instructor, and evaluator on larger aircraft such as the Boeing 707 and the C-130 Hercules. This time was not entered in the survey but it impacted my decisions on training. Additionally, I instructed over 500 hours on a Class II training device, plus classroom instruction for air traffic controller "ab initio" training. This training was aimed at learning the IFR basics, flying approaches, and Crew Resource Management.

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10.05.-12:48 - the status of the basic elements of flying is to low according to the present JAA-regulations. Most of the students are not able to react from there instincts during an incident or accident; they are only able to handle an aircraft under normal operations. To fly an aircraft is a complex process with the correct knowledge of situational awareness. You only can learn this in real life, not in a simulator.

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13.06.-15:32 - IT IS DIFFICULT TO BREAK THE TRAINING DOWN INTO SEPARATE BLOCKS AS THE PROCESS IS CONTINUOUS, WITH OVERLAPPING TRAINING ELEMENTS -- WHILE SOME OF THE PARTICULAR ELEMENTS OF THE RESPECTIVE TRAINING TASKS CAN BE TAUGHT IN A SIMULATOR, THE INTEGRATION OF THE TASKS CAN REALLY ONLY BE ACHIEVED IN AN ACTUAL FLIGHT ENVIRONMENT WHERE THE DYNAMICS OF DIFFERENT ENVIRONMENTAL FACTORS COME TOGETHER AND A CERTAIN DEGREE OF 'UNPREDICTABILITY' COMES INTO PLAY AS WELL

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08.07.-17:39 - Some of the tasks above can of course be trained simultaneously like 31 and 34/35. 36 (CCC) should preferably be trained starting latest with Multi engine basic flying and than continuously (sic) until the end of the training.
I strongly believe that as much actual flying as possible, at least 40%, will improve decicion (sic) making and manual flying skills.

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27.07.-12:54 - Prior to entering an Airline, I feel it is IMPERATIVE that a pilot should have flown lighter aircraft (e.g. BE58/C402 etc.) SA226/BE1900, C208, etc. in various environments (e.g. critical airstrips, bad weather, etc.) where they have to make decisions themselves, before entering an airline where they will be constantly supervised, and possibly overridden, on decisions. This in the long term will make the pilots better Commanders, and possibly, also make it possible for them to become Commanders in a shorter time.
It is also felt that MANAGEMENT of the cockpit and New Flight Management Systems should be brought in at an earlier stage in a pilot's training, as Flight Decks are becoming much more sophisticated and complicated. This is especially true when transiting from older type transport aircraft to more modern airliners.

## APPENDIX F (page 3 of 3)

Unusual Attitudes including spinning (sic) recovery should also be an important aspect of training, even for airline crews.