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Exploring the Implementation of Line Oriented Flight Training on a Maritime Navigation Simulator

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Thesis submitted to achieve the degree of Master in Nautical Sciences

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Preface

For my master's thesis in Nautical Science, I was resolved to do actual empirical research. To provide a personal contribution to the academic world–albeit in a miniscule way. Since I study at the Antwerp Maritime Academy, the decision was made to initiate a research that would hopefully contribute in a way to the maritime world. In the process of writing my bachelor thesis, I developed an interest for Human Factors and how to manage them in a ship's bridge environment. I already knew that managing Human Factors is part of the Maritime Resource Management course. This course consists out of pure classroom and computer-based sessions. I wondered if and how these Human Factors could be trained in practise. After a quest through papers and articles, I could not find any coursebook or methodology that describes how MRM and HF could be practically trained in a maritime context.

Then I decided to have a look at the aeronautical industry. After all, it is closely related to the maritime industry and MRM itself also originated from there. It was immediately apparent that this industry conducts exponentially more research than the maritime world and I found many theories, methodologies and actual manuals on how to practically train HF in the form of non-technical skills.

Line Oriented Flight Training caught my eye in particular. It is a long-standing, greatly researched and frequently used, practical training methodology that basically combines technical and non-technical skills in realistic full-flight simulation sessions. This concept of combining technical and non-technical skills on a simulator intrigued me immediately. Because this method is beneficial for the aeronautical industry, I was convinced that in the very least LOFT merits an exploratory research on our maritime navigation simulator. The idea was that maybe in the future –after much research – LOFT may receive a maritime sibling-version (which I would call Bridge Orientated Navigation Training or BONT), just like Crew Resource Management induced the creation of Maritime Resource Management.

Thus, I decided that any such research should start with exploring whether the LOFT methodology actually can be used in a maritime context at all. Maybe LOFT would prove to be completely irrelevant and not applicable on a maritime navigation simulator, for all I knew (this would equally constitute the immediate cessation of the BONT fantasy). Specifically for this master's thesis, I decided to study the LOFT methodology, translate it from the aeronautical towards the maritime industry, create an entire LOFT session and empirically test it on the navigation simulator of the Antwerp Maritime Academy with test subjects.

To end I would like to thank my promoter professor Christophe Collard and co-promoter captain Axel Annaert for their excellent guidance and support during the process of writing this thesis and I am grateful for the inside information provided by Franco Scala. I would additionally like to thank my family and my close friends who supported me greatly over the entire process.

Abstract

Line Oriented Flight Training is a proven method in the aeronautical industry that is used to train students' technical and non-technical skills in a standardised way. It is related to managing and handling an aeroplane in an as close as possible to real-life situation on a full-flight simulator. In the maritime industry no such standardised methodology exists to train bridge officers. The goal of this research is to explore if and how LOFT can be implemented for training purposes on maritime navigation simulators. One entire scenario was scripted through theoretical analysis and application of the standard LOFT procedures. This scenario was then empirically tested on the navigation simulator Polaris of the Antwerp Maritime Academy, Belgium, against both a treatment group and a control group of test subjects. The result of this research is that LOFT can indeed be implemented on a maritime navigation simulator. This conclusion opens future research opportunities on the use of LOFT for training purposes in maritime academies.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ADDIE	Analysis, Design, Development, Implementation, and Evaluation
AMA	Antwerp Maritima Academy
AQP	Advance Qualification Program
ALRS	Admiralty List of Radio Signals
BPG	Bridge Procedures Guide
BRM	Bridge Resource Management
CBT	Computer-based Training
CRM	Crew Resource Management
E.S.	Event Set
E.T.	Event Trigger
EBT	Evidence Based Training
ECDIS	Electronic Chart Display Information System
ETA	Estimated Time of Arrival
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite System
GPS	Global positioning system
IALA	International Association of Lighthouse Authorities
ICOA	International Civil Aviation Organization
ISD	Instructional Systems Development
JTA	Job Task Analysis
LOE	Line Oriented Evaluation

LOFT	Line Oriented Flight Training
LOS	Line Operations Simulation
MRCC	Maritime Rescue Coordination Centre
MRM	Maritime Resource Management
RoRo	Roll-on Roll-off
RPM	Rotations Per Minute
SBT	Simulation-based Training
SMCP	Standard Maritime Communication Phrases
SPOT	Specific Operational Training

Introduction

In the aeronautical industry, simulator-based training for pilots is subjected to clear regulations and well-researched and -defined training methodologies. Each of these methods has their own philosophy on how to improve SBT and prepare the pilots for the real world in the best way –both theoretically and practically. In the nautical industry –as for now –no real standardised methodology for training future bridge officers in a simulator-based environment is in place. Any technical profession's skill-requirements can be divided in industry specific 'technical' skills and 'non-technical' skills. Non-technical skills –which are linked to human factors –are what they call Crew Resource Management skills in the aeronautical industry and is defined as ''the cognitive and social skills of flight crew members in the cockpit, not directly related to aircraft control, system management, and standard operating procedures'' (Flin et al., 2003, p. 96). Respectively, in the nautical industry Maritime Resource Management was developed, based largely on CRM. These non-technical skills accompany the navigator's technical skills, and their goal is to "reduce errors, increase the capture of errors and help to mitigate when an operational problem occurs" (R. Helmreich et al., 2003). The existing MRM courses –devised largely by The Swedish Club –are a combination of classroom and Computer Based Training. The global objective of this thesis is thus to find and try out whether technical and non-technical skills can be taught jointly in a fully standardised way, from a practical point of view –meaning on the navigation simulator. As will be discussed later on, Line Oriented Flight Training as part of Line Operations Simulations is a well-researched and widely spread methodology in the aeronautical industry that tries to do exactly that.

The specific goal of this thesis is to experiment and try to translate the well-defined LOFT methodology from the aeronautical towards the maritime industry. The two industries are on some levels quite similar, so this general initiative of lending their ideas and apply or transfer them into a maritime context is far from new. E.g., the aforementioned MRM, which originated from CRM (Wahren, 2007).

The thesis is subdivided in two parts; 'Part One Theoretical Framework' will discuss what is needed to provide the reader with the necessary theoretical background information on what LOFT is, where it comes from, what the exact purposes are, the exact methodology itself presented as a step-by-step guide, how and when the specific lists should be used. Part One should be seen as a theoretical foundation or build-up towards 'Part Two Scientific Research'. The second part is completely dedicated to the translation, creation and empirical testing of an entire LOFT-session supplemented with everything that goes with it[1]. The entire layout of the chapters throughout Part Two is devised in the exact same way as the LOFT methodology prescribes[2], in order to make it more organised and consistent for the reader to follow.

To accommodate the creation of the script and the accompanying scenario for the empirical testing, a visit was made to the 'CAE Oxford Aviation Academy Brussels - Sabena Flight Academy'. There an interview with the training manager, chief simulation instructor, Franco Scala took place. The purpose of this visit was to find out how the Brussel's flight academy organises their simulation sessions, how and when they make use of LOFT and other relevant information for this thesis. The extensive and fruitful interview was followed by a visit to the full flight simulators and the accompanying quarters, where the instructor indicated how and where the sessions take place. This added a physical or practical dimension to the theory behind LOFT. The Brussel's flight academy uses indeed LOFT for –some –of their simulation sessions. They have however added several personal practises to the standard LOFT methodology, which they believe –from own experience –improves the sessions. Thus, this interview and their implementation of LOFT will be used as a source for this thesis.

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[1] Standardised checklists, scenario, script, etc.
[2] Also as discussed in Part One.

Part One Theoretical Framework

Chapter 1 Line Operations Simulations

1.1 What is LOS

When considering flight training, two main goals are usually pursued. The first one is that the trainee should be able to bring every stage[3] of normal flight to a good end, by demonstrating adequate skill. The second lies in it to prepare the trainee in dealing with any eventuality that can occur at any time, as during flight many unpredictable events can happen. To succeed in both goals, the trainee needs to be well qualified in both technical skills –the actual operation and control of the aircraft –and non-technical skills –which are the CRM skills, like decision-making, group communication, leadership, workload management, etc. These two sets of skills need to be applied simultaneously by the trainee during flight in order to be able to succeed in reaching both aforementioned goals. To the present day there is no methodology in place more successful in pursuing these goals than Line Operations Simulations (Curtis & Jentsch, 2019). Also, Captain R. W. Hamman (2010, p. 242) stated that "It has become evident that LOS is the most appropriate environment to train and evaluate both technical and CRM skills", when discussing the ever improving technology of flight simulators. He also cornered –in the same work –that the name LOS can be replaced by full-mission simulator for interpretation purposes. By this he meant that LOS should be seen as a means of fulfilling or reaching a certain 'purpose'. These certain purposes can be numerous and different in nature. E.g.. "LOS can be used to aid in the development and evaluation of operating procedures and new equipment, proficiency checking, pilot selection for new-hire programs, or cockpit human factors research" (2010, p. 240). When LOS is specifically utilized for training purposes, it is called LOFT. This implies that LOFT is a subcategory of LOS and this will be discussed more succinctly in a subsequent chapter.

[3] F.i., taxiing, taking-off, landing, etc.

Throughout the professional career of a pilot the bulk of his experience can be labelled as normal flight operations. To complete these routine flights successfully, it suffices to be trained for standard operational procedures only. This way of training, however, cannot prepare a pilot sufficiently for non-routine or emergency situations –which happen rarely. Yet, it would prove physically impossible to practise every scenario that contains a certain combination of non-routine aspects of flight, because there is an infinite number of possible variations. Furthermore, over time -especially from one year on – clear signs of training abatement start to appear, principally on infrequently trained aspects –such like non-routine operations (Arthur Jr. et al., 1998; Childs & Spears, 1986). This is exactly why it is of paramount importance to include non-routine procedures on a frequent basis in a pilot's training, without jeopardising routine flight operations training. This concept of versatile repetition roots from Klein's (2008) recognition-primed decision-making. This means the more diverse your experiences are, the better you are equipped to handle complicated situations. To put it differently, the more a person's memory is filled with versatile sorts of experiences or skills, the more likely s/he is able to complete a job under a series of different circumstances.

To provide the trainees with the theoretical basis and concepts of flight, classroom sessions form a fundamental part of training. Nonetheless, practical flight sessions are where the theoretical bases can be put to use and this is where the major learning process and progress will take place. It is evident that the optimal means of attaining this is through real-life flight experience. Regrettably, providing all[4] the practical flight sessions via real-life flight sessions on board of aeroplane is due to logistical, organisational, economical and safety reasons impossible to provide. The optimal alternative to imitate a real-life flight, is on a computer-based flight simulator (Kanki, 2010, p. 268). The simulator tries to recreate all aspects of flight as close as possible to reality and are usually located at flight academies or dedicated training facilities. However, the building costs and operational expenses of such a flight simulator are quite excessive, resulting in a relatively limited amount of them being constructed. Consequently, these simulators have to operate round the clock in order to

[4] N.B., real-life flight sessions are genuinely being organised, but for the reasons provided they are kept to a minimum –usually reserved only for the final stages of the training.

satisfy the high demand for practical flight sessions. For that reason, it is imperative that the available simulation time is used most efficiently, and this in order to recreate an as close to reality as possible simulation session. If that time is merely left to the instructor to fill at will[5], many of the vital training objectives will either be missed-out or not emphasised adequately. This will result in an inefficient simulator session for the trainees. Alternatively, every simulation session should have a well-defined scenario, scripted in advance with clear objectives in mind. This scenario should reflect on what the trainees have seen during theoretical classroom sessions and these should be translated in a practical in-cockpit application. A simulation session is a practical implementation of what has been discussed in theory, that is where it should start to work from. Everything discussed until now on simulated training sessions, is currently applied in the most suitable way by following Line Operations Simulations methodology (Kanki et al., 2019).

LOS must be seen as a tool that guides you in creating a close to real-life scenario, to be used –amongst other, for training or instruction purposes –on computer generated simulators (Chidester, 1993). The United States' Federal Aviation Administration (Federal Aviation Administration, 2015) defines LOS as a multitude of equivalent procedures that create gate-to-gate scenarios in a computer-based simulated context, which has either one of the two following purposes: training or evaluation. What must be understood from this, is that LOS is not intended to be used for the creation of clear instructions that go with one specific situation or element of one flight-phase. Rather, the created scenario should trigger the trainee to combine his technical and CRM skills in order to deal with the situation in an orderly and safe manner. Additionally, the entire scenario should start where real-life flight operations start; the same goes for the ending, and this then is what gate-to-gate means[6]. In conclusion, the most crucial part in LOS is the scenario development, notwithstanding that there are other important parts[7].

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[5] I.e., if no structured or standardised training methodology is followed.

[6] In other words, the entire scenario starts from flight preparations to taxiing from the gate of departure to take-off to landing and all the way to arrival at the destination gate.

[7] Like: considering training requirements, technological capabilities, supplemental material for the simulated world, etc.

Line Operations Simulations can be broadly defined as a simulation-based training method. SBT is not only well established in the aeronautical industry, but also in the military and medical sectors (Salas et al., 2006, 2008). Proving that it is not uniquely applicable for aeronautical purposes, this already gives an indication for possible applicability within the maritime industry. SBT refers generally to a training method where the trainee is exposed to real-life situations from which he gains practical experience by addressing challenges trough combining different collections of skills. This can be achieved by inserting special events in the scenario that would trigger such behaviour (Salas et al., 2006).

1.2 Different types of LOS

In total there are three types of LOS: Line Oriented Flight Training, Specific Operational Training and Line Operations Evaluation. These are governed by the United States' Federal Aviation Administration under the Advanced Qualification Program. The FAA defines Advanced Qualification Program as follows:

> *AQP provides an alternate method of qualifying and certifying, if required, pilots, Flight Engineers (FE), flight attendants (F/A), aircraft dispatchers, instructors, evaluators, and other operations personnel subject to the training and evaluation requirements of parts 121 and 135. AQP is a systematic methodology for developing the content of training programs. AQP incorporates data-driven quality control (QC) processes for validating and maintaining the effectiveness of curriculum content. AQP encourages innovation in the methods and technology that are used during instruction and evaluation, and efficient management of training systems.* (Federal Aviation Administration, 2015, pp. 1–2)

Both LOFT and SPOT are used for training purposes. Dissimilarly, LOE is used to evaluate whether a trainee has reached a certain level of proficiency. All three make use of SBT as development tool, each for its own objective.

1.2.1 Training purpose

The goal of both LOFT and SPOT is to create a training environment where trainees can implement technical and non-technical –or CRM –skills. This training environment is strictly ruled by the non-penal attitude – i.e. meaning that the trainee must not be afraid to make an error or failure, for there are no direct negative consequences –even if flight performance is clearly substandard. LOFT is a genuine gate-to-gate based simulation method, as it contains scenarios of all phases of flight[8] to provide the trainee an as full as possible flight experience. More specifically, the phases encompass aspects like; flight preparations, checklists and other paperwork, all radio-communication, following standard procedures, etc. LOFT can be used for either qualification or recurrent training, see chapter 2 (Chidester, 1993). It has been claimed repeatedly throughout multiple papers that the LOFT methodology delivers the optimum and most efficient training results by combining both technical and CRM skills (Barshi, 2015; R. Helmreich et al., 1991; Jensen, 1989).

SPOT as oppose to LOFT is not a gate-to-gate simulation session, but is used to train one or multiple individual elements of specific flight objectives. These fall usually within one or a few phases of flight. SPOT is particularly valuable when there is limited time, the instructor can choose to jump immediately into a phase of flight to train the specific element of interest. Another purpose could be to provide a trainee additional exercise if s/he has difficulties with one specific element, e.g. landing; the instructor can replay the landing sequence over and again until the trainee has practised to proficiency.

[8] I.e.: pre-flight, in-flight and post-flight scenarios are all part of the simulation.

The two seem quite comparable, however, since each has its own strict educational use and one cannot replace the other (Butler, 1993). The biggest difference between the two is how much the instructor is involved during the simulation session. In a LOFT session, the instructor forms no part of the onboard crew, he plays all the supporting roles to the simulation –amongst others, radio connection with the ground as part of air traffic control. It is imperative that the instructor does not interrupt the sessions for instructional purposes, or any other reason not part of the simulation scenario (Federal Aviation Administration, 2015). By not providing directives –or help –during the session, the trainee is encouraged and challenged in deciding on the best suitable action for that particular situation –this enhances self- and crew-realization (R. L. Helmreich & Foushee, 1993). Alternatively, SPOT focusses on perfecting a particular training goal. As in the example given hereabove, the instructor can guide and instruct the trainee, if required he can replay the scenario. The goal is to train to proficiency by providing sufficient practise moments.

Both training methods combine routine and non-routine – emergency –flight situations in the scenario.

1.2.2 Evaluation purpose

LOE is used to evaluate the performance and proficiency level of the trainee or pilot[9] under the AQP qualification standard. It is much comparable to LOFT; LOE is a lifelike gate-to-gate simulation, no intervention from the instructor-evaluator is allowed during the simulation. The distinction lies in the core of LOE, here the trainee will be assessed based on his situation-specific and overall performance. Nonconformities or substandard performance will result in failure of that particular session, which could have negative consequences for the trainee's progress and certification (Kanki et al., 2019).

[9] When recertification is required.

1.3 CRM and MRM

In the aeronautical industry, Crew Resource Management has become the established and widely recognized method to train operational personnel –not exclusively pilots –in recognising and dealing with problems that concern human factors. CRM distinguishes itself from typical theoretical human factors training programs, by introducing experimental examples, explaining exactly and create genuine understanding of what the non-technical skills are for a specific group or target audience. The goal of which is to provide them with the skills necessary to handle themselves as well as the group in a safe and effective manner. This program was *ab initio* created specifically to help pilots deal with cockpit-crew related human factor problems. Quickly, the CRM philosophy dissipated beyond the cockpit environment, first toward branches within the aeronautical industry. Later, to other industries altogether, where safety and group performance –in both routine and non-routine operations –is imperative to the proper functioning. More specifically; the maritime, health care, rail and offshore industries (Hayward et al., 2019).

In the beginning of the 1990s the maritime industry set-up to create its own Bridge Resource Management training program. Seven[10] organisations decided in 1992 to start a cooperation with the Scandinavian Airlines System Flight Academy and drew-up a first worldwide BRM training program. This enterprise was founded on the assumption that the already exciting research and knowledge conducted for CRM in the aeronautical industry, would be favourable to the maritime industry likewise. Thus, a lot of what was part as CRM was translated –for maritime purposes –towards BRM (Hayward et al., 2019). History proved this assumption to be accurate. In 2003, BRM was reworked –largely by the Swedish Club –and renamed to become Maritime Resource Management to better accommodate the new and more versatile application of resource management[11].

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[10] These are: Dutch Maritime Pilots' Corporation, Finnish Maritime Administration, National Maritime Administration Sweden, Norwegian Shipowners' Association, Silja Line, the Swedish Shipowners' Association, and The Swedish Club.

[11] The target group is now not only bridge personnel, but also engine room personnel, maritime pilots, shore-based personnel.

The current MRM training program consists of video-based analyses of maritime and aeronautical accident reports, conducted in group. These are supplemented with individual computer-based training segments, where theoretical aspects of human factors[12] are explained more practically. Some programs include in the final stage a role-play, where participants can try out the freshly obtained MRM or non-technical skills.

MRM –or BRM –has progressed a long way from when it was first introduced. However, still a lot of improvement needs to take place in order for MRM to arrive to the same level as CRM (Barnett et al., 2004).

[12] The bachelor thesis: "Human performance ability onboard seagoing vessels: The ability of a bridge officer to deal in an efficient and safe way with digital and analogue information input" is a literature study that offers an introduction to human factors and their relevance for bridge officers. This is only to be considered as background reading.

Chapter 2 Line Oriented Flight Training

2.1 What is LOFT

The United States' Federal Aviation Administration provides a clear and succinct definition of LOFT:

> *LOFT is a useful training method because it gives flightcrew members the opportunity to practice line operations (e.g., maneuvers, operating skills, systems operations, and the operator's procedures) with a full flightcrew in a realistic environment. Flightcrew members learn to handle a variety of real-time scenarios that include routine, abnormal, and emergency situations. They also learn and practice CRM by way of operator-developed behavioral markers that may include, but are not limited to, essential elements such as situational awareness, communication, decision making, workload management, and automation management skills. The overall objective of LOFT is to provide training that improves total flightcrew performance, and thereby preventing incidents and accidents during operational flying.* (Federal Aviation Administration, 2015, p. 5)

Captain William R. Hamman described LOFT analytically, by providing six distinct characteristic features unique to it. These features provide not only a good explanation, but also highlight the profound way LOFT discerns itself from any other kind of training method. Those reasons make his contribution relevant to this thesis, thus it merits to be quoted.

The distinct features particular to LOFT:

1. *LOFT is the application of line-operations simulation to pilot-training programs. LOFT is a combination of high-fidelity aircraft simulation and high-fidelity line-operations simulation.*

2. *LOFT involves a complete crew, each member of which operates as an individual and as a member of a team just as he does during line operations.*

3. *LOFT involves simulated real-world incidents unfolding in real time. Similarly, the consequences of crew decisions and actions during a LOFT scenario will accrue and impact the remainder of the trip in a realistic manner.*

4. *LOFT is casebook training. Some problems have no single, acceptable solution; handling them is a matter of judgment. LOFT is training in judgment and decision-making.*

5. *LOFT requires effective interaction with, and utilization of, all available resources; hardware, software, and ''liveware,'' or the human resources. A LOFT scenario requires the exercise of resource management skills.*

6. *LOFT is training. LOFT is a learning experience in which errors will probably be made, not a checking program in which errors are not acceptable. The purpose of LOFT is not to induce errors, but cockpit resource management is, in part, the management of human error. Effective resource management recognizes that under some circumstances, such as 'night-workload situations, human error is likely; steps must be taken to reduce the probability of error. However, it is also necessary to maximize the probability that error, when it does occur, will be detected and corrected, thereby minimizing the probability of adverse impact upon the overall safety of the operation. Just as it is necessary to practice landing skills in order to gain and maintain aircraft-handling proficiency, it is necessary to practice human-error-management skills; the former requires a simulator or airplane, and the latter the presence of errors or error-inducing situations.*

(Hamman, 2010, pp. 241–242)

Figure 1 The Confluence of advanced simulation technology and CRM illustrates that before the introduction of LOS and the accompanying LOFT methodology, human factor skills were managed and developed only through theoretical classroom sessions. Later on, these human factors were developed in a more specific CRM set of skills, which could be used more purposefully in a cockpit environment. As for technical skills, these were trained in real-life flight sessions onboard of aeroplanes[13]. This situation of technical and non-technical skills being trained separately evolved into the combination of the two and thus the creation of LOS. Flight sessions -whether real-life or simulated –would now become the moment in training to practice and gain experience not only in technical aspects of flight, but CRM skills equally (Lauber & Foushee, 1981a, 1981b).

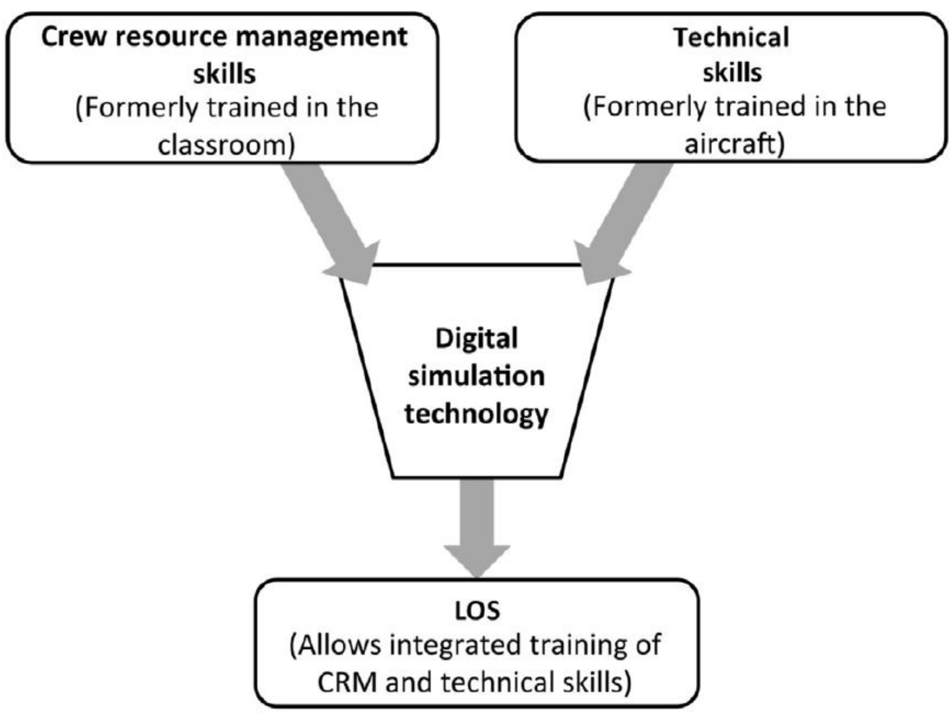

Figure 1 The Confluence of advanced simulation technology and CRM

Source: Hamman

[13] Remark that this was mainly due to technological restrictions. Only by the 1970s the technology advanced enough for simulators to begin to replace real-life flight sessions (Page, 2000).

2.2 Instructional System Development

The US' Federal Aviation Administration uses the Instructional System Development as a guideline for developing and implementing Advanced Qualification Programs. Since LOS falls under AQP, any implementation of LOS –LOFT more specifically for this thesis –should occur according to this guideline. The programme is more commonly known under the name "ADDIE", the abbreviation stands for Analysis, Design, Development, Implementation, and Evaluation (Molenda, 2003). This programme works as a cycle; you start in the 'Analyse' phase, and once the goal of that phase is reached the process continues by going to the next phase in chronological order until all phases have been processed. When arrived at the final phase[14], the idea is to recommence this procedure as a way of ongoing cyclic enhancement. This cyclic movement is represented by Figure 2 The ADDIE model of instructional systems development.

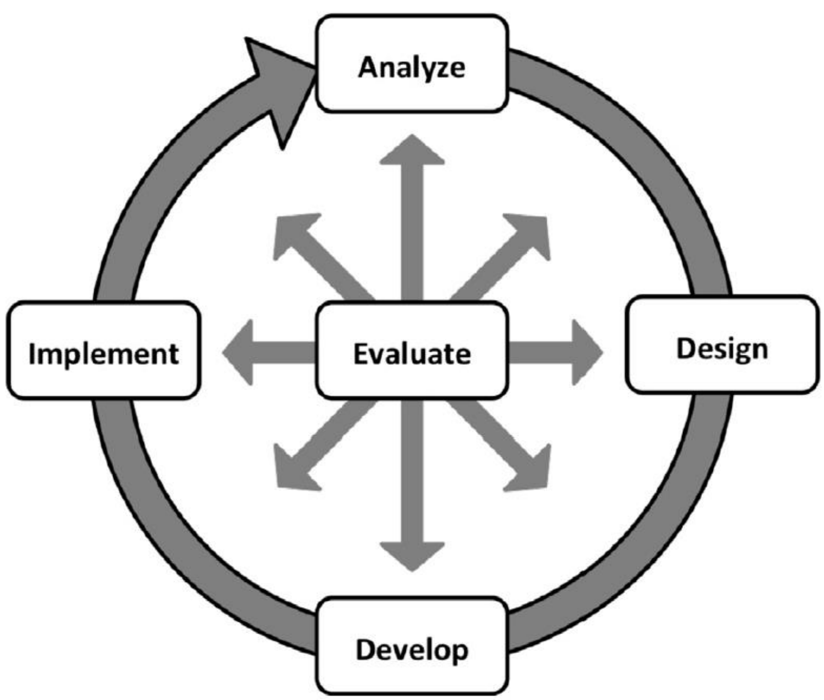

Figure 2 The ADDIE model of instructional systems development.

Source: Koteskey R. W., Hagan C. & Lish E.T. 2019

[14] N.B., one can recommence the procedure at any phase if deemed necessary –although this usually occurs after the final stage.

The rest of this chapter will be dedicated to provide and explain in short, step-by-step fashion how ADDIE should be used to create a LOFT session. This step-by-step guide is taken directly from the Crew Resource Management handbook, chapter 10 “Line Oriented Flight Training: A Practical Guide for Developers” (2019, pp. 288–319). If some aspect is not clear or deeper elaboration is desired, the reader is kindly invited to have a look at that handbook.

2.2.1 Analyse

The goal of this phase is to find out what you want the trainees to learn from the session. To do so, first must be defined what they already know or can do. The gap between the two is the reason why you desire to create a training session (Dick & Carey, 1990). From here you can define clear training goals and objectives for your LOFT session.

Prerequisite Skills

Write down what the trainees’ current skills are or must be, in order for them to be able to join this particular session. What is the minimum required entry knowledge?

Learning Goals

Here, it is time to set a general goal for your session, as this will help to work in the direction of a clear and focussed scenario. Since any LOA session tries to represent a real-world environment, it is a good idea to look for ideas in some kind of real-world data[15]. In the aeronautical industry the AQP defines and regulates clearly what the goals should be for a LOFT session. For any other industry, try to find any kind of regulations as a guideline for what the general goals should be or create them yourself in your own way.

[15] Like accident reports, company specific training requirements, etc.

Learning Objectives

After defining broad goals, it is time to define specifically what you expect the trainees to have learned after the session. What changes do you expect to see in their behaviour and actions? Mager (1984, p. 6) stated the following about learning objectives: "Objectives . . . are useful in providing a sound basis (1) for the selection and designing of instructional content and procedures, (2) for evaluating or assessing the success of the instruction, and (3) for organizing the students' own efforts and activities. . .".

Airlines are provided with big lists filled with training objectives where they can readily pull from, namely: the Job Task Analysis. The Crew Resource Management handbook (2019, p. 292) defines a JTA as follows:

> *A JTA exhaustively describes and catalogs the individual components of the job that a pilot does in his or her crew position. It lists the entire spectrum of behaviors that a qualified pilot should display while doing their job. This includes not only physical and technical skills, but also cognitive abilities like problem-solving and CRM skills. To the LOS developer, the JTA is a palette of observable behaviors from which to draw. Not all behaviors need be observed; you can pick the ones you feel are important for a particular training session (LOFT), or that represent a common set of skills that need to be evaluated (LOE), and plug them into the list.*

For any other target industry –if there is no JTA list available or pre-made –construct one yourself[16]. You can start compiling your JTA list, by adding the objectives that you come-up with –for each of your LOFT sessions –as you go from one session to the next. When you define objectives and categorise them into a JTA, it is useful to think how you are going to grade or evaluate these objectives. What are the capabilities, the behavioural markers, expected actions related to each objective?

[16] Since you will have to define objectives anyway, you can in addition categorise them into a list as you progress.

Over time –when your JTA list becomes well filled –designing new LOFT scenarios will become easier and quicker. This is because the general idea is to take elements (objectives) from your standardised JTA list that fit with your newly defined goal and use them as building block for your next LOFT scenario.

2.2.2 Design

By now you have stated what minimum knowledge or skills the trainees will require to engage in a particular LOFT session, as well as the general goals and specific objectives of the training. This stage contains the actual writing of the scenario, where you want the students to learn to reach your pre-set goals and objectives. The scenario should be written by means of a script, which will contain particular trigger-events and background-events that will create life-like atmosphere.

Event Set

Every scenario consists out of events sets, which are the big building blocks each separately dedicated towards one phase of flight. Any technical or non-technical skill –that you took from the JTA –will be organised per Event Set. Furthermore, every Event Set is subdivided into Event Triggers, supporting conditions, and optional distracters.

> *"The event trigger is the condition which fully activates the event set and provides the instructor/evaluator with a specific time segment to focus the assessment process. Supporting conditions are other events taking place within the event set designed to further CRM and technical training objectives and to increase event set realism. The optional distracters are conditions inserted within the event set time frame that are designed to divert the crew's attention from the event trigger or other events taking place within the timeframe of the event set."* (Seamster et al., 1995, p. 664)

The E.T. induces a particular scripted event to occur. E.g. the appearance of an auto-pilot breakdown alarm, or traffic control calls in for a regular situation update, etc. Distractors are used for misleading or taking attention away from the main event, which is the E.T. in this case. As opposed to E.T., distractors can be introduced in one and keep distracting the trainees over the course of several Event Sets. Supporting events can be added to an E.T. trigger to give it a deeper character. It can give an extra dimension or difficulty –if needed – to an E.T. It is important to note that everything contained within one Event Set, should be as realistic as possible and reflect real-life situations. It does no longer seem realistic to have five different alarms to occur over the course of 30 minutes of simulation. This scenario will be near impossible for the trainees to succeed at and will have an overly detrimental influence on their training –which can never be the case for any kind of training.

Amount of Event Sets

There is no exact number for the perfect amount of Event Sets to take place in one LOFT session. However, there should be enough of them to give the trainees the opportunity to prove themselves capable of dealing with challenging situations and eventually learn something. If there are too little, the overall difficulty of the session will be too low and the trainees will all have high grades without ever having to use or train their skills. The ground rule is; less is more. The session should be not too long and not to short[17], not too hard and not too easy. This balance should be found for every scenario, let the goal and objectives be the driver for how many Event Sets you need.

Recurrent and Qualification Training

Devising a LOS session for training purposes can be either of the recurrent type or qualification type depending on the goal in mind.

In recurrent training the trainees already have substantial prerequisite skills. This means that –as opposed to qualification training –the instructor will not or rarely engage with the trainees during the simulation –for guidance purposes.

[17] For LOFT this is between two and four hours of actual flight time.

> *"Recurrent training focuses on refreshing technical skills, realigning the students' CRM behavior, or at the least, to reassure the students that they comply with corporate or fleet expectations. This type of cyclic training is critical to CRM longevity, and recurrent training is the prime opportunity to reinforce these skills."* (Crew Resource Management, 2019, p. 298)

The idea behind qualification training is that it contains multiple follow-up LOFT sessions, every next one building on the progresses of the previous one. The during last LOFT session, trainees should be subjected to all phases of flight and technical and CRM skill objectives should be met. Here the focus lies slightly more on training technical skills[18]. The trainees, here, are less experienced and require more exercise and help from the instructor. Typically –in qualification raining – it is more acceptable for the trainee to intervene during simulation for instructional purposes.

For both types, usually a classroom info moment is held to inform the trainees on the generalities of the sessions and to set some basic expectations. This will set the trainees' behaviour –during the simulation –off in the right direction.

Recurrent training will be chosen for this thesis' empirical testing, because organising multiple follow-up sessions –as qualification training demands – could not be attained for this research.

Level of Difficulty

"A series of Event Sets must afford sufficient challenges for the crew's technical and CRM skills. However, the LOS must be constructed so that it will not adversely increase the crew's workload to the point that they are overloaded" (Crew Resource Management, 2019, p. 299). It is true that in real-life, situations with a series of –extraordinarily many –emergencies or breakdowns can occur. This does not mean that organising that kind of sessions should be the standard –these situation are extremely rare after-all. The idea behind any LOS sessions is to recreate an as realistic to life as possible training environment, for that, it is not required for the scenario to be exceedingly complicated.

[18] This does not mean that CRM skills are discarded, however.

Multiple Branches for Each Scenario

It can be interesting to think about creating alterative Event Triggers or entire Event Sets, to substitute the once that are in the current scenario. These substitutions should still have the same training goals, objectives and difficulty. Doing this is particularly interesting when the same scenario is intended to be used for multiple training groups. The problem is that after the first group has completed your LOFT session, some will inevitably inform the following groups about scenario details. This way the following trainees will already know what will come, this completely jeopardises the LOS philosophy by introducing a clear bias and eliminating the element of surprise[19]. This problem is solved by changing some elements of the scenario for each training group.

Available Resources and Limitations

It is important at this phase to consider what simulator you have at your disposition for training purposes. What are the limitations, capabilities, availabilities, possibilities, etc? It can be a big and expensive full-flight simulator, which allows for any kind of scenario to be created. Still, even there must be something it is not capable of doing. Or maybe there are not enough free time-slots for you to do research, because it is too busy for other purposes. You may also have a small and simple simulator, that has many operational limitations. You must ask yourself questions like; is my simulator capable of creating the environment with all the elements of my scenario, or not; is the training facility willing to provide me some time-slots for research, etc. The answers to these kinds of questions are fundamentally decisive for your entire LOFT session.

[19] This is fundamental to recreate a real-life simulation situation.

Documenting Event Sets, Objectives, and Observable Behaviours

Now that all the preceding steps have been accounted for, it is time to actually start writing the initial LOFT scenario. Figure 3 Sample of LOFT Event Sets. Illustrates how a sketch or brainstorm of your scenario can be devised and organised. Every phase of flight has been categorised in a dedicated Event Set. For each phase of flight, the Event Triggers, supporting conditions, and optional distracters are in brief included. This already provides a general view on how your scenario is going to look like and what it is about.

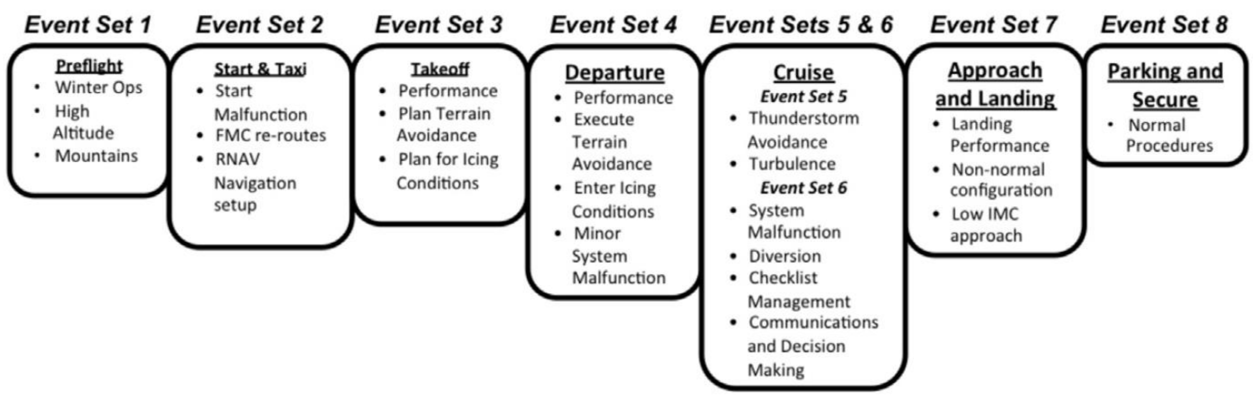

Figure 3 Sample of LOFT Event Sets.

Source: Koteskey R. W., Hagan C. & Lish E.T. 2019

This representation is suitable to write down first ideas. However, as you progress through the creation of the script, more detailed information can be added under the form of a list or matrix –whatever representation is preferred. This information can be; desired trainees' behaviour or course of action, specific background settings like weather or surrounding traffic; specific learning objectives, etc.

2.2.3 Development

Now that the scenario is scripted, it is time to find out if the infrastructure at your disposition is able to execute all the aspects of each Event Set. The development phase is about determining whether the simulator is capable of producing the desired LOFT session. In this phase every element of the script will be tested – e.g. is the simulator at hand capable of producing an auto-pilot breakdown at a specific time and place during the session? Since every LOS sessions mirrors a real-life situation, one must also consider providing communication with the simulated outside world[20].

Training Device Considerations

No simulator is perfect, as there will always be problems or limitations of some kind. It is vital to sort out which elements of the scenario pose difficulties and solve these issues during development.

It is an advantage when the simulator is capable of doing preposition, reposition, and repeat points during the session, for this gives the instructor the freedom to concentrate more on the trainees instead of on the simulator. Identify the most likely position or moment for the trainees to fail or crash and pre-program a point there at which you can easily restart the LOFT session from –if considered necessary. This is especially of interest if the trainees crash in the beginning of the session. By restarting the sessions from that point, the LOFT simulation and the training can continue.

Consult a simulation operator or any person who is fully up-to-date regarding the simulator's technical abilities, to find out what and how system's malfunctions can be programmed. These should be extensively tested. Also, determine if they can be pre-programmed and repeated in case of a reposition situation.

[20] In a maritime context those would be: coastal radio stations, vessel traffic service, pilot radio service, intercom to contact on board personnel, etc.

Weather is a vital factor in any simulation; either it fulfils a background purpose, or it is part of an Event Trigger. One must determine what types of weather phenomena are available and how they can be introduced. It is good practise to verify whether the representation is realistic –on the simulator's tv-screens, the radar and the resultant physical influence the weather has on the movement of the simulator.

All the communication between the trainees and the instructor or operator should be verified to be realistic. All rules and procedures in force should be meticulously followed. For that reason, it is a good idea to write down a script for the instructor to read from when the need presents itself during the session.

It is always considered to be good practise to preprogramme triggers like; weather, malfunctions, breakdowns, traffic, etc. As mentioned earlier, this will allow the instructor to concentrate more on the trainees rather than on the simulator's software. The advantage of preprograming is that any trigger can be summoned by the single push of a button. *Nota bene*, when preprograming is impossible, include clear instructions in the script for the operator or instructor –this will reduce the amount of time attention is away from the trainees. It will also serve as a reminder not to miss out the trigger.

Flight Papers and Documents to Support the Simulated World

To create a realistic session, it does not suffice to program everything into the computer and launch the simulation. In real life, pilots are also supported by all the necessary documentation and paperwork, like: procedural checklists, go-round procedures, voyage plan, weather forecast, fuel on board, etc. Consider what flight information or paperwork is required and provide these to the trainees. These are not only vital, but they will also create an even more accurate simulation environment.

Nota bene, if the trainees are not familiar with the aeroplane –or vessel in our case –structural and other specific on-board information must be provided. Those would be: dimensions of the vessel (length, draught and width), engine specification (telegraph speeds, turning direction and number of propellers), manoeuvring and handling capabilities (turning angle, stopping distance), etc.

Instructor Materials

The instructor or operator makes sure the LOFT session is correctly simulated. To make sure he can do this in the best way possible, clear and concise instructions should be provided to inform him what has to happen where. This can be under the form of a script, where the instructions are clearly marked and time-in-simulation related. That way it is clear during the session when a new element of the scenario should be engaged. Particular care must be taken to ensure this script is easy to read in the poorly lit environment of the simulator's control room. Pay particular attention to: font; font size; bold, italic and underlined words, colour, markings, etc. When well-managed, these can improve readability substantially. Distinguish the exact radio-communication text clearly from the rest of the script, for easy access.

Developing Grade Forms

As everything in LOFT, the grade form also falls under a standardised development approach. Since the training objectives are taken from the JTA list, these objectives should make-up the grade form. The mindset behind creating these forms is to provide evaluation on the trainees' behaviour in order for them to learn from their mistakes and develop progress. To do this, there must be well-defined behavioural indicators included for each training objective, on the bases of which evaluation can take place. One must also define what a passing grade is and a procedure for failing a trainee if performance of certain Event Sets is substandard.

> *"You'll have to develop separate grade sheets for each LOFT and for each LOE scenario option. Definitions must be provided for end-level proficiency, conceptual proficiency (cognitive skills), and for what constitutes completion of the flight segment. Additionally, it is probably wise to have leadership predetermine grading standards under certain conditions within specific event sets. You'll likely want to ask for guidance on defining things like what constitutes a "failure," a "repeat," or a "debrief-to-standards," among others."* (Crew Resource Management, 2019, p. 309)

Grade forms and evaluation sheets will be discussed further in Chapter 3 of this part of the thesis.

Beta Testing

The general idea of beta testing is to discover the issues, design incompatibilities or mistakes –which will unavoidably be present –in your script. These will in turn have to be rectified and tested over again. This implies that the script –or even the scenario – is in a state of continued improvement, until every element of the script has been tested on the corresponding device. It can prove useful –at this stage –to predict how much time the trainees will need to fulfil every Event Set or Event Trigger[21]. This allows for the implementation of a timetable or schedule into the script, for maintaining a better overview of the situation during the session.

This is also the stage where test flying –or sailing –will take place. Special attention –from a maritime perspective –should be paid to: are the required ports and navigation charts available and accurate, both visually as on the instruments like radar; are charted depths correct and aids to navigation visible and at the correct positions; etc. "You'll look for design flaws such as errors in the scripting, gaps in initial instructor training, or areas where the simulators do not support the scenario. You'll also determine the corrective action to be taken" (Crew Resource Management, 2019, p. 311). If a substantial part of the scenario has to be altered or deleted altogether[22], now is the final moment in development where you still can and should do it.

Only upon decision that the entire scripted scenario is flawless and works to perfection, you can move on to the next phase.

2.2.4 Implement

At this phase you take your extensively prepared LOFT project in its entirety to practise in real training sessions with trainees. Depending on your long-term objectives, you might find the need to produce multiple LOFT scenario for follow-up sessions.

[21] N.B., the developer of the LOFT session is biased –he knows the scenario. The trainees are not, which means it will probably take them more time to complete tasks and elements of the scenario than predicted. This uncertainty must be accounted for in the timetable.

[22] Due to the discovery of a fundamental flaw, simulator limitation or any other aforementioned reason.

Train the Trainer

Depending on how big your organisation is, the functions of LOFT session developer, instructor, operator, and evaluator can either be combined in one single person or a dedicated staff member for each function. If the latter is the case, classroom moments are organised by the developer to brief and guide the instructor, operator and evaluator through the scenario. Discussions will take place to collectively agree and align every staff member on the scenario's philosophy, training goals, training objectives and the overall purpose of the particular scenario. Holding these classroom sessions is particularly important if LOFT is a newly introduced training methodology in your organisation (Dismukes, et al., 1997). Some guidelines from the CRM manual on these classroom sessions:

> *In addition to covering the learning objectives of the LOS, there are some general topics that will be always appropriate for additional conversation with instructors. These basically revolve around the fundamentals of LOS:*
>
> - *LOS events should be conducted in real time. Avoid using speed multipliers or position freeze. The exception here is when simulating long haul flights.*
> - *For LOE make the event as realistic as possible. Don't interject yourself. You aren't really there. Use headsets, radios, proper ATC communication procedures and full taxi routes. You can answer questions when queried as ATC, Dispatch, Maintenance Control, etc. but don't offer solutions. Role play realistically. Try to provide the information and ask the questions that flight attendants and ATC would really require. Be professional and avoid shortcuts. If a procedure is required in the airplane, then do it in the LOE.*
> - *In LOFT the instructor may provide input to the crew, but most learning is intended to occur via facilitated debrief after the event has concluded as opposed to on the spot via immediate debriefings.*
>
> (Crew Resource Management, 2019, pp. 314–315)

Training the Debrief

When the scenario is terminated, a conducive debriefing takes place –the final stage of the LOFT session –provided by the evaluator. Here too, it is vital that the evaluator is familiarised with and fully agrees on the LOFT mentality. The basic concept is that a debriefing is a conversation between trainees and evaluator, where there is no completely right or wrong answer. In the end the trainees –as a crew –decided on the actions taken during simulation, therefore the evaluator must focus the discussion on how and why the scenario processed as it did. A way to analyse this process is to facilitate the trainees in reconstructing their own actions –chronologically if helpful –and guide them in realising what action or decision were good or not so good. The instructor should create an open and interactive atmosphere, where s/he and the trainees are on the same hierarchical level. One way this can be facilitated is by asking –preferably open –questions instead of providing direct statements on good and bad behaviour. Another way is to strictly depersonalise the entire discussion[23] by speaking in 3rd person. (Dismukes, et al., 1997, Chapter 6)

Training the Grade Forms

Here too, the instructor –or whoever fills in the forms –should be trained in grading according to LOFT. The fundamental concept here is that comments on the trainees' behaviour and actions will be valued largely over simply distributing numerical marks. For that reason the comments must be relevant, well-founded and objective. An example from the CRM manual illustrates why comments are fundamental to filling in grade forms:

> *For example, a crew who fails to run a certain checklist might reasonably have this error graded as a problem with checklists, situational awareness, workload management, or some combination of the three depending on who views the event. In this scenario, the comments will ultimately be far more useful to the person who later analyzes grade forms than the specific grades.* (Crew Resource Management, 2019, p. 315)

[23] Meaning, not to link any mistake or wrong action to a particular person.

2.2.5 Evaluate

The purpose of the evaluation phase is to find out whether LOFT through the ISD model is working for your organisation or not. LOFT is a simulation-based training method, thus, the idea is that training objectives –specific for your organisation –are met. In the evaluation phase you set out to objectively determine exactly that. From a scientific point of view, objective assessment necessitates data collection and analysis. "With good data you can assess effectiveness of the training, the performance of individual students, and the effectiveness of instructors and evaluators. It can also be used to refine and modify the training so that it continues to meet changing needs" (Crew Resource Management, 2019, p. 316).

Evaluation of a LOS session can have two different purposes. First, the situation where you seek to continuously re-examen and upgrade your existing scenarios built on assessment and analysis from dedicated research groups, with the intention to keep enhancing your LOFT sessions over time. For this you will need a specialised institute or organisation within your own facility with extensive resources for data analysis, to provide you with these assessments and analysis. If that is the case, you will need to engage in mass data collection in order to feed the quantitative data analysis. Second, the situation where you simply want to introduce or implement a new methodology in your organisation. The purpose here is only to establish whether this methodology can be applied in your organisation or not. It is perfectly possible that LOFT –or any LOS for that matter–is simply not suited to be implemented in your industry (Hayward et al., 2019). In the evaluation phase this can be determined. If that is the case, then you should abandon LOFT and pursue another methodology. To determine this, a limited amount of data will suffice.

The evaluation of the empirical study of this thesis will be based on the second of the two purposes of evaluation.

Chapter 3 CAE Oxford Aviation Academy Brussels

As mentioned in the Introduction, a visit was paid to the CAE Oxford Aviation Academy Brussels to gain first-hand information on where and how the LOFT methodology is actually being put to practise. The simulation training manager was interviewed on: how they conduct simulation-based training, whether they actually use LOFT, how and for what purposes do they use LOFT and do they have any advice as to how we might implement LOFT in a maritime context. This chapter will be dedicated to discuss and elaborate on what information has been gained which in the end proved relevant and useful to create the LOFT session for the empirical tests of this thesis.

For simplicity purposes, from here on until the end of this chapter, the CAE Oxford Aviation Academy Brussels will be referred to in short as 'the flight academy'.

A general remark is that the flight academy is indeed using LOFT. However, they add a few elements on top of the standard methodology[24]. They do this, because they found –via personal practical experience –that these have a favourable impact on the training and learning process. In essence, they added some elements taken from Evidence-Based Training and some of their own device.

[24] As described in chapter 1 and 2 of this part of the thesis.

3.1 EBT contributions

EBT is also a methodology in the aeronautical industry that strives to train students to become proficient and qualified pilots. A few definitions should suffice to provide an idea of what EBT stands for.

> *Evidence Based Training applies the principles of competency-based training for safe, effective and efficient airline operations while addressing relevant threats. ICAO has defined competency as the combination of Knowledge, Skills and Attitudes (KSAs) required to perform a task to a prescribed standard under a certain condition. EBT prioritizes the development and assessment of a relevant global competency framework and aligns training content with the actual competencies necessary, in context. (International Air Transport Association, 2011, p. 2)*

The EBT manual contains “a complete framework of competencies, competency descriptions and related behavioural indicators, encompassing the technical and non-technical knowledge, skills and attitudes to operate safely, effectively and efficiently in a commercial air transport environment” (International Civil Aviation Organization, 2013, p. 30).

3.1.1 Job Task Analysis

As stipulated in the LOFT methodology, a JTA must be used –or created if non-existent–in the ‘Analysis’ phase. The ISD, technically, does not compel any LOFT developer to follow the exact same format provided, on how a JTA should be made up or look like. The flight academy made good use of this freedom. They resorted to a format and lay-out provided by the EBT manual to create their JTA list. This format is called “Assessment And Training Matrix” and is –compared to the one provided in the ISD –more comprehensive and better organised. It is also standardised in such a way that it is easy and convenient to keep updating and adding elements. Effectively, it facilitates enlarging the list over time in a more intuitive and straightforward way (F. Scala, personal communication, 6 October 2020).

For those reasons, the decision has been made to follow the flight academy’s example and also use the EBT’s “Assessment And Training Matrix” as basis for the creation of a JTA list for this research.

Annex A is an example taken from the EBT manual on what such an "Assessment And Training Matrix" looks like. (International Civil Aviation Organization, 2013, pp. 58–60) Next comes a guide on how to use this matrix.

> 'Assessment and Training Topic': these are general topics that come from real-life data analysis, these topics are considered to be interesting for training purposes.
>
> 'Description': more detailed information on the *Assessment and Training Topic*
>
> 'Desired Outcome': here it is indicated what to most appropriate outcome or behaviour is, related to the topic.
>
> 'Example scenario elements': here practical examples are provided of how a particular topic can be introduced in a simulation. This list is not exhaustive, instructors can add specific scenario examples at own discretion.
>
> 'Competency map': the competencies that are crossed, are considered to be of importance and relevant to fulfil or attain the desired outcome. The competency map is also useful for determining what combination of topics will provide the best scenario to train or gain experience in a particular competency.

Adding up multiple assessment and training topics will result in the creation of a scenario. To choose which ones to add up, you first have to determine which exact competencies[25] you want to train –search in the vertical direction. Next, you look at which topics are linked –via a cross –with that particular competency, now search in the horizontal direction. Then you choose an example scenario element from the same topic, that fits the best to your needs — look in the same row as that of your chosen assessment and training topic. All that rests to do is defining whether the example scenario element is an Event Trigger, supporting condition or an optional distracter. Finally, allocate it to an Event Set and this is how to use the assessment and training matrix for the creation of a LOFT scenario(F. Scala, personal communication, 6 October 2020).

[25] Or training goals and objectives, to use LOFT phraseology.

3.1.2 Core Competencies and Behavioural Indicators

Continuing from the matrix mentioned hereabove, in the competency map, eight core competency and behavioural indicators are listed. These are not only useful for determining the desired training goals and objectives, but also for evaluation purposes. Annex B Core Competencies and Behavioural Indicators is a list taken from the EBT manual that the flight academy uses to categorise important competencies or skills a pilot should have. These are technical or non-technical (CRM) skills, which are clearly defined. For each, an entire series of behavioural indicators is mapped out. Put differently, there is a list that contain actions, decisions, behaviour of a trainee that is linked to its corresponding competency or skill[26] (International Civil Aviation Organization, 2013, pp. 73–76). The absence of or non-compliance to these behavioural indicators is an indication that the trainee is not proficient at that particular competency. This list helps to objectively and well-reasoned evaluate trainees. (F. Scala, personal communication, 6 October 2020)

[26] E.g., if you would want to evaluate the "Leadership and Teamwork" skills (competency) of a trainee. You need to read the "Behavioural Indicators" which corresponds with that "Competency" and ask the question: did the trainee exhibit any of these indicators or not. On the basis of this, you can base your evaluation.

3.2 Flight academy's own contribution

3.2.1 Developing Grade Forms

Annex C (F. Scala, personal communication, 6 October 2020) is a copy of an actual trainee's evaluation form in use at the flight academy. Since the LOFT methodology does not specify any particular evaluation form format, this one will be used as an example to create the 'Grade Form' for this research.

3.2.2 Briefing

At the flight academy it is standard practise to provide –during the briefing of a simulation session –a classroom-like moment. The purpose is to refresh or go over theory that has previously been covered by a dedicated theoretical classroom course. The theory that is being refreshed is in some way relevant or will be of importance during the upcoming simulation exercise. It is not the intention to reveal scenario details. The idea is to touch several aspects of flight without going into much depth, thereby serving as a reminder of what the trainees already have seen. Now that these aspects have been reminded, it is up to them to remember and revise –from memory –as much as they can about that particular course. They will mentally prepare themselves for anything in that area of theory to pop-up –in some way or another –during the simulation.

The trainees remember theory –albeit only partially –by superficially reminding them of it. Subsequently, immediately applying some of it in practise on the simulator, creates a strong link between theory and practise. This should help the trainees to remember certain procedures or theory for a longer time (F. Scala, personal communication, 6 October 2020).

Annex D is a copy of an instructor's guide or script for a simulation session[27] at the flight academy. On the first page under briefing an example can be seen of some explanation being scripted, for the reasons mentioned hereabove. This practise will also be included in the script for the empirical testing of the LOFT session of this thesis.

[27] N.B., in this particular example the simulation is not a LOFT session. However, this practise does not contradict or interfere with the LOFT philosophy. Subsequently, it can be supplemented to the briefing of a LOFT session.

Part Two Scientific Research

This part of the thesis is fully dedicated to the development of the LOFT simulation and the actual empirical testing. The theoretical background and specific stipulations of the LOFT methodology discussed in Part 1, will be put into practice in this part. All the necessary procedures will be followed as thoroughly as possible and practical.

Chapter 1 Analysis

Prerequisite Skills

The test subjects are 4th year students in Nautical Sciences at the Antwerp Maritime Academy, Belgium. Technical knowledge of the simulator has to be adequate; they should be familiar with the controls of all the equipment present on the bridge. Additionally, BRM, GMDSS, Maritime English (SMCP), Chart Work, Radar, COLREGS, and SAR courses should all be completed successfully.

Learning Goals

To stablish or define the learning goal of our session, we shall start with a standard or typical situation/procedure that requires technical skills –like normal or coastal voyage –and insert cues to trigger non-technical skill behaviour (emergency/ malfunction / break-down, …) on the go.

The goal hereby is to still be able to maintain technical/standard aspects of navigation while cues are added. These cues will make the situation more complex. The underlying idea is that solving the rapid developing situation will require the implementation of non-tech skills (CRM) in order to cope with the situation, all the while maintaining overall safe navigation.

Learning Objectives

According to the LOFT-methodology, the learning objectives should be taken from the Job Task Analysis. Since for the maritime industry no such list exists, our own JTA list had to be devised.

In order to facilitate future developments or enlargements of the JTA list developed for this research, the Manual of Evidence-based Training (EBT) approved by the International Civil Aviation Organization will be used as a guideline. This methodology is not only widely accepted in the aeronautical industry[28], but also completely standardised.

Job Task Analysis

See Table *1* Assessment and Training Matrix.

[28] Among others CAE Oxford Aviation Academy Brussels uses EBT methodology.

Table 1 Assessment and Training Matrix

Source: Own material, Original Source: EBT Manual

Assessment and training topic	Description (include type of topic being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Scenario elements	Application of procedures	Communication	Vessel sail path management, automation	Vessel sail path management, manual	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Assessment and Training Matrix				Competency map							
Adverse Weather	Thunderstorm, heavy rain, turbulence, ice build-up to include de-icing issues, as well as high temperature conditions.	Anticipate adverse weather Prepare for suspected adverse weather Recognize adverse weather Take appropriate action Apply appropriate procedure correctly	Restricted visibility due to rain and mist	x			x		x	x	
			Heavy seas due to wind, waves and swell	x			x		x	x	

Manual vessel control	The competency description is “Maintains control of the vessel in order to assure the successful outcome of a procedure or manoeuvre”	Desired competency outcome: Demonstrates manual vessel control skills with smoothness and accuracy as appropriate to the situation Detects deviations through instrument scanning Maintains spare mental capacity during manual vessel control Applies knowledge of the relationship between vessel speed and thrust	Auto-pilot or steering gear breakdown; manual steering	x			x		x		x
			Loss of GNSS signal; manual position fix	x			x		x		x
Vessel system malfunc-tions	Any internal failure(s) apparent or not apparent to the crew	Recognize system malfunction Take appropriate action including correctstop/go decision	Auto-pilot and steering gear breakdown	x			x		x		x
			Loss of GNSS signal	x			x		x		x

	Malfunctions to be considered should have one or more of the following characteristics: Immediacy Complexity Degradation of vessel control Loss of primary instrumentation Management of consequences	Apply appropriate procedure correctly Maintain vessel control Manage consequences	Main Engine Failure	x			x		x	x	
Port approach, visibility close to minimum	Any situation where visibility becomes a threat	Recognize actual conditions Observe vessel and/or procedural limitations Apply appropriate procedure if applicable Maintain directional control and safe flight path	Port approach in heavy seas and restricted visibility	x				x	x	x	x

Anchoring or docking	Navigators should have opportunities to practise anchoring and docking in demanding situations at the defined frequency Important factors include appropriate decision-making, in addition to manual vessel control skills if in difficult environmental conditions The purpose of this item is to ensure that navigators are given exposure during the programme	Anchoring or docking in demanding environmental conditions	Anchoring in sea-anchorage	x			x		x		x
Maritime Radio Station	MRT errors, omission, miscommunication, garbled or poor-quality transmission	Respond to communications appropriately Recognize, clarify and resolve any ambiguities	Communication with pilot station	x	x						x

		Refuse or question unsafe instructions Use standard phraseology whenever possible									
Traffic	Traffic conflict, or visual observation of conflict, which requires evasive manoeuvring	Anticipate potential danger Recognize danger Take appropriate action Apply appropriate manoeuvre correctly Maintain vessel control Manage consequences	Engage in collision avoidance according to Colregs	x					x	x	
Vessel system management	Normal system operation according to defined instructions	This is not considered as a stand-alone topic It links with the topic "compliance" Where a system is not managed according to normal or defined procedures, this is determined as a non-compliance	Deck logbook	x						x	
			equipment check	x						x	x
			Familiarisation passage plan	x					x	x	x
			Navigation in coastal waters	x				x	x	x	x

Emergency; not with own vessel	Any Safety, Urgency or Distress situation not related to own vessel	Upon reception or visual observation act according to prescribed GMDSS procedures	Mayday call received	x	x				x	x	x
Compliance	Compliance failure. Consequences of not complying with operating instructions This is not intended to list scenarios, but instructors should ensure that observed non-compliances are taken as learning opportunities throughout the programme In all modules of the programme, the simulator should as much as possible be treated like a vessel while non-compliances should not be accepted simply for expediency.	Recognize that a compliance failure has occurred Make a verbal announcement Take appropriate action if necessary Restore safe sail path if necessary Manage consequences		Intentionally blank							

Chapter 2 Design

Event Sets

Standard situations A, B, C and D are the Event Sets. X the Pre-Sail will also be regarded as one.

The cues A1, B1, C1, C2 and D1 are the Event Triggers.

B1 is a large Event Trigger, the part the MRCC plays is here the Supporting Condition.

The Optional Distracters here are the traffic and general collision avoidance.

Event sets:

- X) Pre-Sail; preparations
- A) Change of Watch; visibility fine, sea state normal
- B) Normal Coastal voyage; visibility fine, sea state normal
- C) Normal Coastal voyage to Port de Tanger Enter TSS; visibility worsens half-way (mist, rain).
- D) Approach to Port de Tanger; overall deterioration of weather, stormy +- 7-8 Beaufort to enter port, anchor at sea-anchorage.

Event Triggers:

A1) Change of watch

B1) Incoming distress message (GMDSS) received on VHF in area A2 ➔ need to relay

C1) Auto-Pilot followed by Steering Gear: breakdown

C2) GNSS: No-Signal

D1) Main Engine: loss of RPM.

Recurrent Training

Since the test subjects have a basis, this training is opted as oppose to Qualification Training. The basis here being that the test subjects have already studied three years at the AMA – i.e. they have gained enough experience so as not to be new to the concept of simulation training. They have –in theory –already learnt what they need to know in order to sail. However, in these simulations they will put theory to the test. Practice makes perfect idea is applicable here, for that reason 'Recurrent training' fits our needs the best.

Level of Difficulty

The Event Triggers 'Pilot drop off', 'Echo Sounder breakdown' and 'AIS breakdown' have been discarded. They were found to increase the workload too substantially, so that an information overload situation was deemed to occur almost certainly. This would render the scenario unrealistic, and for that reason they were removed from the scenario.

Multiple Branches for Each Scenario

Since this is an exploratory research and not a full-on school application, there is no need to diversify each scenario[29].

Available Resources and Limitations

At the disposition of this research the full navigation simulator 'Polaris' of the Antwerp Maritime Academy was made available. Polaris has a 360° round visual and all of the important navigation aids and instruments are physically present, while the lesser important ones[30] are simply simulated on a computer screen. This means that close to all instruments are present in either physical or simulated version.

[29] It is assumed here that the test subjects of the first experiment will not give away any scenario details on to the test subjects of the second experiment.

[30] Those would be: Navtex, Epirb, …

However, one relevant limitation is to be noted, namely that Polaris is a fixed simulator. Consequently, no real ship's motion can be recreated, which is a substantial factor in simulating as close to reality as possible scenarios. However, the 360° visual -furnished by TV screens -provides to some degree the illusion of movement.

Documenting Event Sets, Objectives, and Observable Behaviour

Table 2 Basic scenario

Source: Own material

Event Set X	Event Set A	Event Set B	Event Set C	Event Set D
Pre-Sail	**Change of Watch**	**Voyage**	**Voyage**	**Approaching Port**
○ Voyage plan ○ Equipment Check	○ Taking over watch ○ visibility fine ○ sea state normal	○ Coastal voyage ○ Incoming distress message	○ Visibility bad ○ Auto-Pilot breakdown ○ Visibility very bad ○ GNSS No-Signal	○ Visibility good ○ Sea State bad ○ Port Approach procedures ○ Main Engine failure ○ Contact Pilot Vessel Service ○ Sea Anchor Area

- <u>X</u>
    - Check and set navigational equipment (see BPG; checklist B6 equipment check) (radar, Ecdis, GNSS, echo sounder, …)
    - Check and familiarise with programmed passage plan on charts, prepare for first waypoints.
- <u>A</u>
    - Event Trigger A1; Change of watch at sea (BPG; checklist B16)
    - Check the traffic in the immediate vicinity
    - Fill in Deck Log Book (General remark)
    - Collision avoidance in accordance with ColRegs (General remark)
- <u>B</u>
    - Engage navigation in coastal waters (BPG; B10 check only relevant points)
    - Event Trigger B1 happens
        - Act according to GMDSS. Plot, do Mayday Relay on MF and communicate with MRCC, …
        - Also, BPG; checklist C9
    - Proceed voyage
- <u>C</u>
    - Event Trigger C1 happens around the time a collision avoidance manoeuvre is required.
        - Follow BPG; checklist C2
    - Restricted visibility (BPG; checklist B13)
    - Event Trigger C2 happens
        - Acknowledge this issue. It cannot be fixed during voyage.
        - Increase vigilance and start Dead Reckoning, visual bearing, … ASAP
        - Position taking interval decreased (take more pos.)
    - Proceed voyage

- D
    - Heavy weather (BPG; checklist B14)
    - Event Trigger D1 happens
        - Acknowledge loss of RPM
        - Follow BPG; checklist C1
    - Proceed approach
    - Tanger Port makes contact.
    - Proceed to anchorage and anchor
- End of simulation

Voyage Scenario Generalities

The vessel -which will be called Polaris -is engaged in a transatlantic ocean crossing. The destination is the RoRo-terminal of Port de Tanger. The simulation starts when the vessel is approximately two hours sailing time away from the port. The simulation ends when the vessel is anchored in the sea anchorage area, located just outside the port breakwater.

Time interval per Event Set:

A) 10 min
B) 30 min
C) 45 min
D) 35 min

Chapter 3 Development

Three sessions took place on the navigation simulator 'Polaris' with the assistance of the Antwerp Maritime Academy's instructors. These sessions were used to discover the abilities and limitations of Polaris, both software- and hardware-wise. Necessary anticipations and amendments to the scenario could this way be established. These specific developments will be discussed in the present chapter.

Training Device Considerations

On Polaris it is possible to make use of Reposition Points. This can be useful if at any stage the trainees make a fatal or unresolvable error rendering the continuation of the scenario impossible – e.g. if the trainees run aground the vessel can be repositioned -for the sake of finishing the scenario- and the session can be continued instead of ending it at that moment.

The following System Malfunctions were tested:

- Auto-pilot and steering gear breakdown: these are present in the interface menu. When activated they provide a clear audible and visual alarm om the bridge. This malfunction can also be programmed to initiate at any given moment in time. It was tested and works fine.
- GNSS No-signal: works same as above and has been successfully tested.
- Main Engine failure: initially seemed to work the same way as the others. However, when tested, the programming for this malfunction to go off at a certain time did not work. The only workable solution was to initiate this live during the actual simulation. Additionally, this malfunction -even though clearly indicated in the software -was failing to produce an alarm of any kind on the bridge. So, the engine does break down, but this will have to be noticed from the actual loss of RPM, speed, engine noise and deterioration of manoeuvrability.

The Weather can be easily programmed through the dedicated menu on the software interface. Fog and rain are a setting in percentage and can be allocated to the entire region or introduced by a multitude of clouds. They can be set to increase and decrease immediately or gradually, in order to make it more realistic. Waves and swell are set in meters of height and wave period for the latter. They are activated immediately for the region or a predefined sector. Same goes for wind and current. The former's speed is set in knots and direction in degrees, for the latter the rate is set in knots and drift in degrees.

All Radio Communication between the bridge and the simulated world can take place via the installed radios, located on both the bridge and the operator's control station. The operator takes care of all non-scripted[31] outgoing calls from the bridge. Simultaneously, he/she provides communication that is part of the scenario, which includes:

- A third-party ship is in distress and sends out a May Day call, which is part of Event Trigger B1.
- Still part of Event Trigger B1, MRCC Tarifa will provide instructions to be carried out by the trainees.
- As part of the standard port approach procedures, the trainees should at a certain point in the scenario make contact with Pilot de Tanger.
- Near the end of the scenario, Port de Tanger calls on to the trainees with more instructions.

These four moments of communication are an integral part of the scenario and should be carried out in accordance with the international requirements[32]. For those reasons, the exact verbiage has been written down in the script in order to facilitate the correctness and swiftness of communication.

[31] Whenever the test subjects initiate a call –for whatever reason –the operator will improvise an answer.
[32] Most notably SMCP and GMDSS.

Preprograming Triggers is not possible with the software. However, a few creative solutions for some of the triggers were found. A rain cloud and fog bank can be programmed to the desired settings and allocated to a geographic position far away from the sector in use, so that is does not show up on any radars on the trainees' bridge. When the time in the scenario comes for the clouds or bank to appear, they can be simply dragged with the cursor over to that place. All the other triggers (weather, malfunctions, communication) cannot be preprogramed[33]. For these a scripted note has been introduced to inform the instructor when to activate a programmed trigger.

Flight Papers and Documents to Support the Simulated World

In real life situations the navigation crew of a vessel engaged in voyage from port A to B is usually familiarised with the vessel, the passage plan, the arrival procedures, manoeuvring characteristics of the vessel, and so on. However, in a simulation the trainees are not. This implies that all of the basic information and data required for the safe navigation and arrival at port has to be provided on the bridge of the simulator. The trainees should have all the paperwork, nautical publications, and other necessary books at their disposal. Next follows a list of all that paperwork:

[33] There is difference between preprogramed and programmed. The latter means going into the menu of the software and setting all the desired conditions to your preferences and subsequently activating it immediately or at a certain specific time. The actual act of setting is required. Alternatively, preprograming means you have already set everything up heretofore and whenever you need to, you can summon the –already programmed –trigger by the push of a single button. Relieving the instructor of the need to search for the menu and settings during the live simulation. Reducing the time, the instructor's focus is away from the trainees.

- Pilot Chart, Ships Particulars and Wheelhouse Poster
- Bridge Procedures Guide
- Deck Logbook
- Passage Plan + corresponding Nautical Charts
- ALRS vol V
- ALRS vol 1 (1)
- ALRS vol 6 (3)

Additionally, as to not bias the trainees into using all of that paperwork[34], a few not particularly relevant publications have been added to the list. They do not contain any voyage specific information, but rather general principles or rules of navigation and seamanship. That list:

- The Mariner's Handbook
- IALA Maritime Buoyage System
- International Regulations for Preventing Collisions at Sea

Instructor Materials

In order to assist the instructor and operator during the simulation, a 'Simulation Exercise Script' was developed. Chapter 4: 'Implementation' of this part of the thesis has been fully dedicated to this topic. However, it is worthwhile to point out that the scenario -which constitutes an integral part of the script -has been developed at this stage of the LOFT methodology. The scenario can be found under "4.1.3 Phase Three: Scenario".

[34] By providing only that what they really need.

Developing Grade Forms

Table *3* Training Module Evaluation Sheet has been developed for grading purpose. What follows is a guide to use it. Whenever a behaviour is deemed to be unacceptable, an 'X' should be marked in the box "Unsatisfactory". This results in an automatic failure of that session. Whenever a behaviour really requires improvement, an 'X' should be marked in the box "Should Improve". This does not result in an automatic failure. However, if multiple 'Should Improve' boxes have been crossed, the instructor can still fail the trainee. In both cases extensive argumentation, justification, and clear grounds should be stated by the instructor in the comments section for that session's failure. Alternatively, whenever the box "Above Standard" is marked, the instructor should similarly provide argumentations for that decision in the comments section.

The assessment of the trainee's behaviour should always be based on the specific markers crossed in the 'competency map' for each 'assessment and training topic'. All of which can be found in Table *1* Assessment and Training MatrixAssessment and Training Matrix. Further detailed analyses and commenting -of every competency related to each training topic - should be based on what is set out in Table *4* Core Competencies and Behavioural Indicators[35]. This approach ensures the evaluation to be more rational, objective, and standardised through eliminating –to some degree –arbitrary and personal subjective opinions[36] on what and how to evaluate.

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[35] N.B, this list is a good guideline, but is certainly not all-encompassing. Instructor's own competencies and indicators can be applicable as well.

[36] N.B. that in this way of evaluation the personal opinion and judgement of the instructor is not discarded as such. Rather more, his personal experience and knowledge should be used to provide comments on the specific pre-set evaluation markers, which are set to be relevant for each training topic. I.e., the evaluation topics are pre-defined. However, it is up to the instructor to provide comments and judgment based on relevant general behaviour indicators –as listed –according to personal interpretation.

Training Module Evaluation Sheet

Table 3 Training Module Evaluation Sheet

Source: Own material, Original source: Sabena Flight Academy

Name student:	Date:

US= Unsatisfactory – SI= Should Improve – SL= Standard Low – S=Standard – AS= Above standard						
	US	SI	SL	S	AS	Comments
Equipment check						
Familiarisation passage plan						
Deck logbook						
Navigation in coastal waters						
Engage collision avoidance according to COLREGS						
Mayday call						
Restricted visibility due to rain and mist						
Autopilot and steering gear breakdown						

Autopilot or steering gear breakdown; manual steering						
Communication with pilot station						
Loss of GNSS signal						
Loss of GNSS signal; manual position fix						
Heavy seas due to wind, waves and swell						
Port approach in heavy seas and restricted visibility						
Main Engine failure						
Anchoring in sea-anchorage						
Compliance						
Items at discretion of instructor						

MRS Communication						
General behaviour						
Seamanship						

Non-Technical Skills						
Communication						
Leadership and teamwork						
Problem solving and decision-making						
Situation awareness						
Workload management						

General Assessment	US	SI	SL	S	AS	PASS	FAIL[37]

[37] In case of a failed evaluation, specify the reason(s) and proposals for extra training on the next page.

	COMMENTS (continued from previous page)
Equipment check	
Familiarisation passage plan	
Deck logbook	
Navigation in coastal waters	
Engage in collision avoidance according to COLREGS	
Mayday call	
Restricted visibility due to rain and mist	
Autopilot and steering gear breakdown	
Autopilot or steering gear breakdown; manual steering	
Communication with pilot station	
Loss of GNSS signal	
Loss of GNSS signal; manual position fix	

Heavy seas due to wind, waves and swell	
Port approach in heavy seas and restricted visibility	
Main Engine Failure	
Anchoring in sea-anchorage	
Compliance	

Reasons for failure, proposal extra training	

CORE COMPETENCIES AND BEHAVIOURAL INDICATORS

Table 4 Core Competencies and Behavioural Indicators

Source: Own material, Original source: EBT Manual

Competency	**Competency description**	**Behavioural indicator**
Application of Procedures	Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.	Identifies the source of operating instructions. Follows Way Points unless a higher degree of safety dictates an appropriate deviation. Identifies and follows all operating instructions in a timely manner. Correctly operates aircraft systems and associated equipment. Complies with applicable regulations. Applies relevant procedural knowledge.
Communication	Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.	Ensures the recipient is ready and able to receive the information. Selects appropriately what, when, how, and with whom to communicate. Conveys messages clearly, accurately and concisely. Confirms that the recipient correctly understands important information. Listens actively and demonstrates understanding when receiving information.

		Asks relevant and effective questions. Adheres to standard radiotelephone phraseology and procedures. Accurately reads and interprets required company and flight documentation. Accurately reads, interprets, constructs and responds to Maritime Radio Station messages in English. Completes accurate reports as required by operating procedures. Correctly interprets non-verbal communication. Uses eye contact, body language and gestures.
Vessel Sail Path Management, automation	Controls the vessel's sail path through automation	Controls the vessel using automation with accuracy and smoothness as appropriate to the situation. Detects deviations from the desired sail trajectory and takes appropriate action if required. Maintains the desired sail path during navigation using automation whilst managing other tasks and distractions. Selects appropriate level and mode of automation in a timely manner considering phase of navigation and workload. Effectively monitors automation, including engagement and automatic mode transitions.
Vessel Sail Path Management, manual control	Controls the vessel sail path through manual control	Controls the vessel manually with accuracy and smoothness as appropriate to the situation. Detects deviations from the desired sail trajectory and takes appropriate action if required.

		Controls the vessel safely using only the relationship between speed and thrust. Maintains the desired sail path during manual navigation whilst managing other tasks and distractions.
Leadership and Teamwork	Demonstrates effective leadership and teamwork.	Understands and agrees with the crew's roles and objectives. Creates an atmosphere of open communication and encourages team participation. Uses initiative and gives directions when required. Admits mistakes and takes responsibility. Anticipates and responds appropriately to other crew members' needs. Carries out instructions when directed. Communicates relevant concerns and intentions. Gives and receives feedback constructively. Confidently intervenes when important for safety. Demonstrates empathy and shows respect and tolerance for other people[38]. Engages others in planning and allocates activities fairly and appropriately according to abilities. Addresses and resolves conflicts and disagreements in a constructive manner. Projects self-control in all situations.
Problem-solving and decision-	Accurately identifies risks and resolves problems.	Seeks accurate and adequate information from appropriate sources.

[38] This behavioural indicator should only be used in the context of debriefing after a session and not be recorded.

making	Uses the appropriate decision-making processes.	Identifies and verifies what and why things have gone wrong. Employ(s) proper problem-solving strategies. Perseveres in working through problems without reducing safety. Uses appropriate and timely decision-making processes. Sets priorities appropriately. Identifies and considers options effectively. Monitors, reviews, and adapts decisions as required. Identifies and manages risks effectively. Improvises when faced with unforeseeable circumstances to achieve the safest outcome.
Situation awareness	Perceives and comprehends all of the relevant information available and anticipates what could happen that may affect the operation.	Identifies and assesses accurately the state of the vessel and its systems. Identifies and assesses accurately the vessel's lateral position, and its anticipated sail path. Identifies and assesses accurately the general environment as it may affect the operation. Keeps track of time and fuel. Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected. Anticipates accurately what could happen, plans and stays ahead of the situation. Develops effective contingency plans based upon potential threats. Identifies and manages threats to the safety of the vessel, people, cargo, and marine environment.

		Recognizes and effectively responds to indications of reduced situation awareness.
Workload management	Manages available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.	Maintains self-control in all situations. Plans, prioritizes and schedules tasks effectively Manages time efficiently when carrying out tasks. Offers and accepts assistance, delegates when necessary and asks for help early. Reviews, monitors and cross-checks actions conscientiously. Verifies that tasks are completed to the expected outcome. Manages and recovers from interruptions, distractions, variations, and failures effectively.

Beta Testing

One full session on the Polaris simulator -of approximately 5 hours duration -was dedicated to beta test the scenario. As described in the sub-paragraphs above; the ‘System Malfunctions’, ‘Weather’, ‘Radio Communication’, ‘Preprograming Triggers’ and other elements were tested actively. Where needed, final settings were tried out, like: the exact Beaufort scale to use so as to not overwhelm the test subjects but still find a reasonable setting with the required difficulty. The same applied to fog, rain, swell, sea current, and wave hight.

Final predictions of how the subjects would progress through the scenario were made, taking into account the factors described in the paragraph hereabove. From that, the exact starting position has been pinpointed as such that the total sailing voyage would indeed be around two hours. Based on that, traffic was introduced at the opportune position and timing, as to accommodate all the Even Triggers. At this stage the timing –which is present in red on the scenario timeline –was introduced as a guideline for the instructor as to when every Event Trigger and any other action has to take place. During the test sail, special attention was paid to whether the visual representation during the simulation corresponded with the information provided by the navigation charts. The most important are the port area and entry, such as breakwaters, buoys, and other physical features relevant to navigation.

It was at this stage that an addition to Event Trigger C1 was introduced. Originally, only an auto-pilot breakdown was scripted. The general idea of this E.T. is to introduce an inability to manoeuvre at the same time a collision-avoiding manoeuvre is required due to traffic. This would make for a critical situation, one that would put the test subject in a demanding situation. However, during test sailing it was established that simply switching over from auto-pilot to manual steering –which takes only the push of one button –is a very intuitive and easy solution to an auto-pilot breakdown. If the test subjects would do that –which was deemed to be very likely –the whole purpose of this E.T. would be missed. Consequently, in order to ensure the purpose could not be evaded that easily, the introduction of a subsequent steering gear jam was added to the script. This would not change the nature of the exercise fundamentally, yet removed considerably the probability of losing the *raison d'être* of this Event Trigger.

Overall, during the beta test no major predicaments were discovered and at this stage all minor hiccups were –presumed[39] to be –taken care of.

[39] "Presumed", because as will be discussed in chapter '5 Evaluation', several problems were still encountered during the first experiment.

Chapter 4 Implementation

For the empirical purposes of this research the entire 'implementation' was transcribed in the form of a 'Simulation Exercise Script.' This script provides detailed and step-by-step instructions as to what to do and say in chronological order during the experiment. It serves as a guide to the operator and instructor. Every aspect of the scenario has been overhauled between the instructor and the Polaris operator. Additionally, every Event Set and Trigger has been reviewed in order to ensure that there is a clear alignment between instructor and operator about the goals and objectives. The 'Evaluation Sheet' and the accompanying 'Assessment and Training Matrix' and 'Core Competencies and Behavioural Indicators' have likewise been overhauled. The importance of providing comments has been reconfirmed to be of a far greater value than simply allocating a grade.

The scenario developed in a previous chapter will –for the purposes of this research –be used twice during two separate experiments with two distinct test groups. The first experiment will thereby be conducted in a non-LOFT mindset, without all of the typical procedures and standardisation. The scenario will simply be introduced to the test subject, after which the simulation will start, and at the end the operator will give a short debrief. The non-LOFT session will be guided by Captain Annaert, in which he will play the role of the simulator operator as well as instructor[40]. He is a very experienced instructor and has been instructor on the simulator at the AMA for many years. Nikita Zazulia (the author of this thesis) will play the role as assistant-operator, mainly for to ensure the simulation proceeds as scripted. Capt. Annaert will conduct this session according to his personal experience and methodology. The second experiment will be conducted according to the LOFT-methodology, meaning the evaluation will happen according to the standardised Evaluation Sheet and all the other accompanying forms discussed hereabove. The debriefing will happen in accordance with the LOFT mindset as well. Additionally, the briefing will be conducted according to the methodology used at the CAE Oxford Aviation Academy Brussels [41]. The one exception is the scenario itself, which will for both experiment sessions be –identical and –developed

[40] For the purposes of this research the instructor will also assume the role as evaluator.
[41] As discussed in Chapter 3, Part 1 of this thesis

according to the LOFT methodology. During the LOFT-session Capt. Annaert will be operator and Nikita Zazulia will be instructor.

The reason behind the two sessions, is to compare how different, feasible, and achievable LOFT is. Also, to determine whether it is practical or not compared to the traditional way simulation exercises are conducted at the AMA[42]. The test subjects of the first experiment can be seen as the control group and those of the second experiment (LOFT-session) can be seen as the treatment group. For tis exact reason the two scenarios must be identical.

[42] The traditional way is represented by the first non-LOFT experiment.

4.1 First Experiment

Simulation Exercise Script

17/02/2021

4.1.1 Phase One: Set-up and Preparation

<u>List of Equipment</u>

- ☐ Video camera + charger
- ☐ Dictaphone + charger
- ☐ Laptop + charger
- ☐ Tripod
- ☐ Clock/ timer + charger
- ☐ SD-Card 100 GB memory
- ☐ Extension cords electric cables

<u>Start-up Simulator</u>

- Start server: Capt. Annaert
- Load exercise; file name: Nikita.Zazulia
- Start-up all nav equipment: radar, GNSS, telegraph, …

<u>Prepare recording equipment</u>

A. Camera on bridge
B. Audio on bridge
C. Set-up Bridge
    1. Both radars:

       North-up, real motion, trials: off, CPA: 1 nm, TCPA: 10 min

    2. GNSS: Nav
    3. Telegraph: Full Ahead
    4. Auto-Pilot: On and set on bridge control
    5. Radio: Ch 16, Volume 100
    6. Charts: 1812, 142, 1912 + pencil, eraser, divider, parallel rulers
    7. Echo sounder: switch off

4.1.2 Phase Two: Introduction to Test Subjects

Welcome Procedure

Arrival test subjects

They are only allowed to enter the simulator room as a group by 1330h, so when they are all present. Suggest they should go to the bathroom before we start. Seat them around the briefing table. Welcome and thank them upfront for their presence.

Program and research goals • Self-presentation • This simulation serves as a practical implementation of LOFT on a maritime navigation simulator. • The main goal of this research is to experiment whether LOFT in itself can be translated towards and used in a maritime context. Of lesser importance, we will try to find through qualitative comparison of data from these simulation experiments, that using LOFT for training purposes can be advantageous for technical and -more importantly for this research -non-technical skills. These are more specifically Human Errors like: MRM, (group) communication, problem-solving-ability, information overload, and others.
Remarks • This simulation is extracurricular to your AMA study, so your actions here will have no effect whatsoever on your grades. The sole purpose is purely academic and all data is highly confidential. • Since the recording of this simulation will start from the moment of the briefing until the debriefing, I would kindly ask you to turn off your mobile phones or put them in full silence mode as to not disturb the recording or any participant, including yourself. For that same reason, please do not take any other smart device with you inside the Polaris simulator. Thank you for your understanding. • If anyone of you needs to go to the bathroom, now you can still go.

Consent of the test subjects

Simulator Research Exercise for Master Thesis Nikita Zazulia

I, named ………………………………………………………………. allow Nikita Zazulia to record my voluntary participation in this research -taking place at the Polaris simulator of the Antwerp Maritime Academy on 17/02/2021 -both audio and visually. I agree that this data will be used strictly for research purposes in an academic context, not exclusively, linked to the thesis *Exploring the Implementation of Line Oriented Flight Training on a Maritime Navigation Simulator* under the terms and conditions mentioned hereafter.

I, Nikita Zazulia, will not falsify or abuse these data in any malicious act, I reserve the right to use and distribute it for academic purposes and also possess the right of ownership. My promotor is Professor C. Collard and co-promoter Captain. A. Annaert.

Thank you for your participation.

Nikita Zazulia   Signature participant

Date: 17/02/2021

Explain data collection

Video, audio and back-play We are interested in your behaviour, actions, communication and problem-solving ability. To assess this on the spot is very difficult, that is why we record so we can analyse everything more profoundly later on. All of the data will be used exclusively for research purposes.
If you have any questions about the data collection, you can ask them now or send me an email.

Presenting the Scenario

- The scenario will take approximately 2 hours
- Ship is on a transatlantic crossing from Norfolk USA towards Tanger port, Morocco.
- You take over the watch during the last segment of the voyage, just off the coast of southern Spain.
- The simulation ends when you dock at the RoRo terminal in Tanger.
- The passage plan has already been drawn-up for you on the paper charts.
- All of the navigational equipment on the bridge is active and at your disposal.
- We introduce just one limiting factor; you will not have ECDIS. However, the GNSS (GPS) is active and functional.
- Make sure you are aware of the required port approach and arrival procedures.
- All books and Admiralty Nautical Publications you might require are present on the bridge.

Some arrangements during simulation

All of our devices have to work synchronised; this means we cannot stop the simulation. That is why we ask the following from you:

-do not take any device with you on Polaris.

-you cannot go to the bathroom during simulation

-this is a full-on navigation simulation; this means nobody will be intervening and you cannot ask any questions concerning the exercise.

Ship's Particulars

Table 5 Ship's Particulars Experiment One

Source: Own material

Name	KMSS DAINTY
Callsign	LKAB
MMSI	257125004
LOA	294.1 m
Draught	12.6 m
Breadth	32.2 m
Displacement	76752 t
Propeller	One Fixed Pitch; Right Rotating
Thrusters	One Bow Thruster
Speed at Full ahead	24.9 knots

Allocation of Roles

The roles of Captain, 2nd Officer and Apprentice-Officer are distributed at random by drawing cards. State to the subjects that regardless of the rank of their given role everyone is responsible for a safe passage. Also, they should divide the bridge duties (look-out, chartwork, radar, manoeuvring, radio-telephony…) according to their own judgment.

4.1.3 Phase Three: Scenario

Start Bridge Recording

- Video camera
- Microphones
- Back-play

Timeline

Table 6 Timeline Experiment One

Source: Own material

Time	Event Set	All events	Details
0600	Event Set X: **Pre-Sail**		• Subjects receive 15 min to prepare before start of simulation as part of preparations for taking over the watch.
0600 - 0610	Event Set A: **Change of Watch**	Start simulation Take-over watch	• Position: N 36° 03' W 006° 40' Course: 112° Speed: Full Ahead Radar Echo's: MV Evergreen Sea visibility fine: xxxxx, sea state normal: xxxxx

0610
-
0640
	Event Set B:
	Voyage
		Navigation in coastal waters
		Incoming distress message
			• Send message on VHF Ch 16
			  ○ First May Day Call at 0610
			  ○ Second Call at 0615
			  ○ May Day vessel does not reply to incoming calls. Subjects should relay and contact MRCC Tarifa
			    ▪ MRCC Tarifa calls on subjects and instructs them to proceed voyage.

0640 - 0725	Event Set C: **Voyage**	Navigation in coastal water Auto-Pilot breakdown (Tanger Pilot) GNSS No-Signal	• visibility bad: xxxxx, sea state normal: xxxxx; at 0640. • At ±0645, must coincide with avoidance manoeuvre for two vessels crossing from SB! If subjects call on intercom: chief engineer solves issue and informs subjects. • Visibility very bad: xxxxx, sea state normal: xxxxx ; at ±0655 • If subjects report ETA to Tanger, Tanger Pilot answers affirmatively. Should be around 0900, see Int Chart 142. • At 0710; if subjects call on intercom: inform subjects this issue cannot be solved during voyage. Proceed voyage.

0725 - 0800	Event Set D: **Approaching Port**	Port approach Tanger Port Main Engine failure End Simulation	• visibility good: xxxxx, sea state bad: xxxxx; at 0725 • visibility good: xxxxx, sea state very bad: xxxxx; at 0730 • Due to heavy weather Tanger Port calls on subjects informing them to anchor in Anchorage Area nr 3 at 0735. See chart 1912. • Reduce RMP to 50% at 0740. Engine shut-down at 0745. Chief Engineer can fix this issue after request from subjects through intercom. • Simulation ends after subjects have anchored the vessel.

Colour key:

Blue text: Event Triggers

0610: Time of Event Trigger

Xxxxx: Specific setting on the simulator, which corresponds with definition (f.i. visibility good)

Text: Indication that the instructor should execute a Radio Telephony Call at this stage in the simulation, for the exact text see hereunder.

Radio Telephony Calls

May Day Call

May Day x3

This is MV Denebola x3

Callsign HELP hotel echo lima papa

MMSI 25 71 25 999

Mayday

This is MV Denebola

Callsign HELP

MMSI 257125999

We are in position N 35° 30’ and W 007° 01’

We had an explosion in our engine room, we will abandon ship.

Over

MRCC Tarifa Call

Mayday

Polaris x3

This is Tarifa MRCC x3

Received Mayday Relay

Question what is your position?

Over

Mayday

Polaris

This is Tarifa MRCC

We have found closer stations to Mayday station. You can proceed with your voyage; we will handle the distress situation from now on.

Request, please acknowledge.

Over

Mayday

Polaris

This is Tarifa MRCC

Have a good voyage.

Out.

Tanger Pilot Answer

Polaris x3

This is Tanger Pilot x3

Your Pilot will be ready for pick-up at 0750. Call again when you are at pilot boarding area. (if requested by subjects boarding area: 8 cables NNE of the head of the breakwaters).

Pleas confirm.

Over

Polaris

This is Tanger Pilot

Well received. Good voyage.

Out

Tanger Port Call

Polaris x3

This is Tanger Pilot x3

How do you read me?

Over

Polaris

This is Tanger Pilot

Due to adverse weather the pilotage service has been suspended and all port entries have been forbidden until further notice.

Request to anchor in anchorage area number three.

Pleas confirm.

Over.

Polaris

This is Tanger Pilot

That is correct. You can proceed.

Out

Simulator Starting Situation

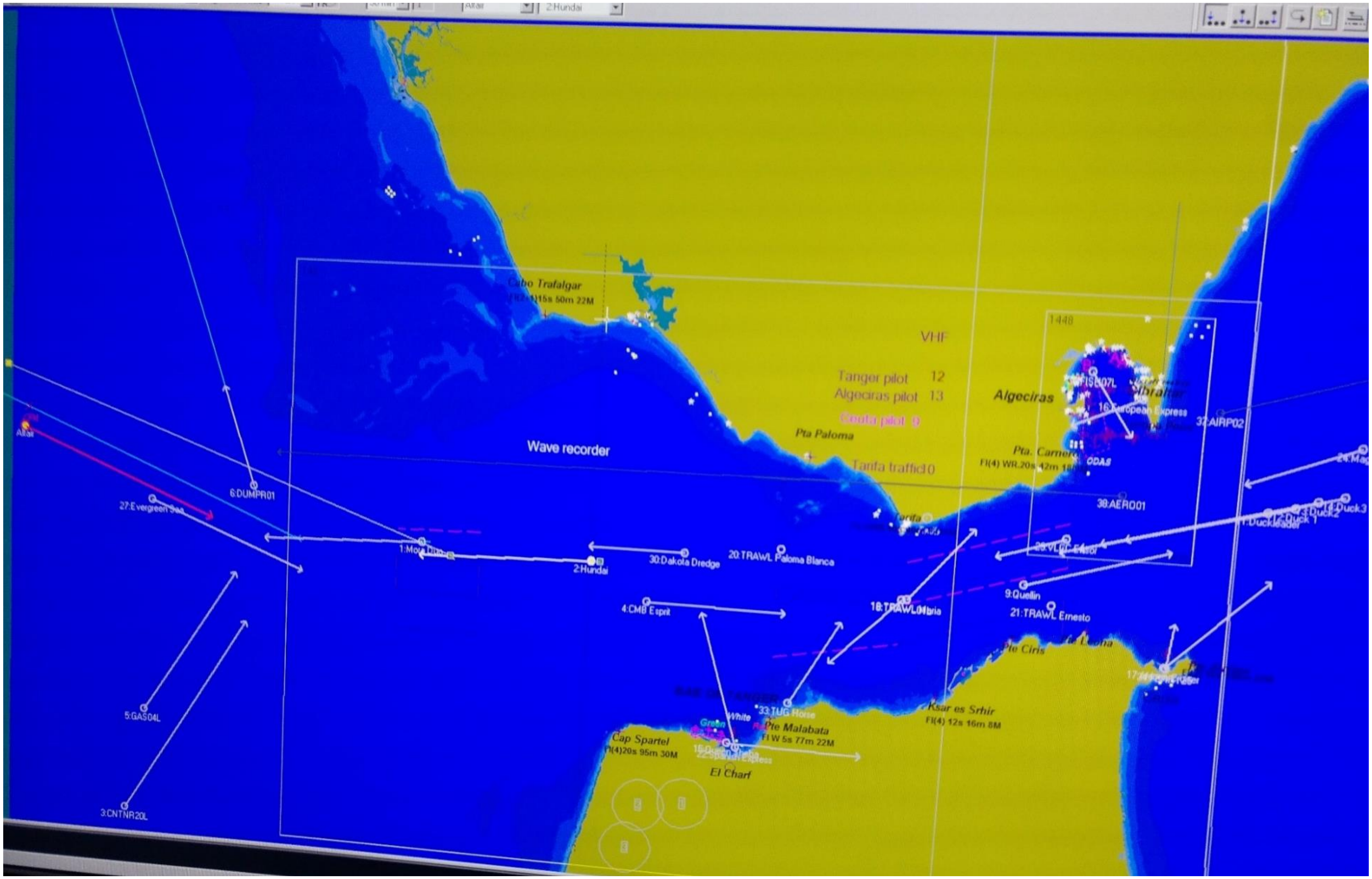

Figure 4 Simulator Starting Situation Experiment One

Source: Own material

Passage Plan on Charts

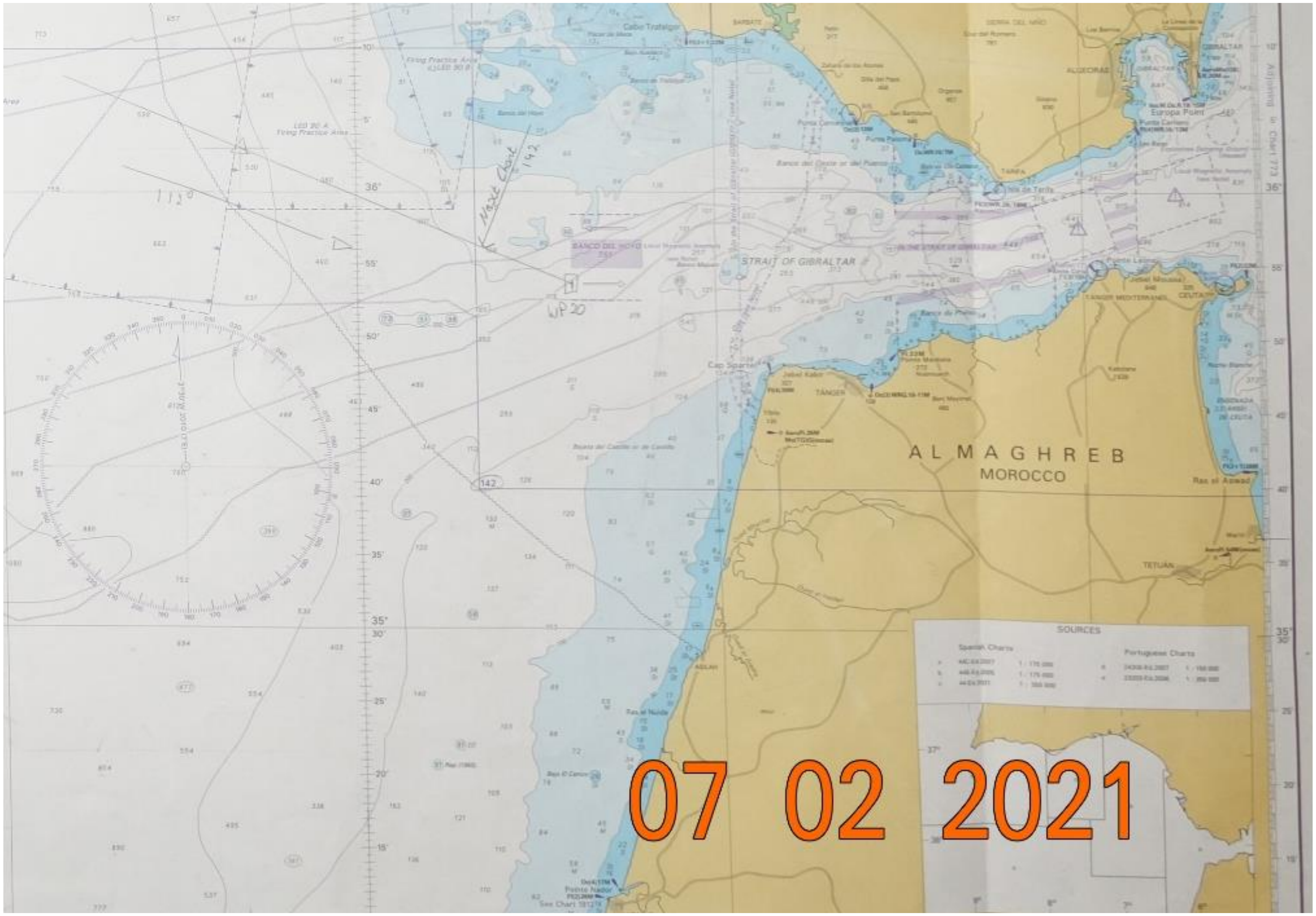

Figure 5 Passage Plan on Charts Experiment One

Source: Own material

Figure 6 Passage Plan on Charts Experiment One

Source: Own material

Figure 7 Passage Plan on Charts Experiment One

Source: Own material

Charts

1st chart: INT 1812= Cabo De São Vincente to The Strait Of Gibraltar.

2nd chart: INT 142= Strait Of Gibraltar

3rd chart: INT 1912= Port De Tanger-Ville

Waypoints

Table 7 Waypoints Experiment One

Source: Own material

Waypoint 20	N 35° 54’ W 006° 18’
Waypoint 21	N 35° 54’ W 006° 05’
Waypoint 22	N 35° 49’ W 005° 47’3
Waypoint 23	N 35° 47’3 W 005° 47’3

4.1.4 Phase Four: End Simulation

Short Debriefing

Stop recording on bridge

- Video camera
- Dictaphone

Debriefing

The operator provides this in the usual way it is done at the AMA (back-play). This should not take more than 10 minutes.

Break-down

- Thank everyone for participating.
- Save all data.
- Clear the simulator of all the material.

4.2 Second Experiment

Simulation Exercise Script

24/02/2021

4.2.1 Phase One: Set-up and Preparation

List of Equipment

☐ Video camera + charger

☐ Dictaphone + charger

☐ Laptop + charger

☐ Tripod

☐ Clock/ timer + charger

☐ SD-Card 100 GB memory

☐ Extension cords electric cable

Start-up Simulator

- Start server: Capt. Annaert
- Load exercise; file name: Nikita.Zazulia
- Start-up all nav equipment: radar, GNSS, telegraph, …

Prepare recording equipment

D. Camera on bridge

E. Audio on bridge

F. Set-up Bridge

1. Both radars:

   North-up, real motion, trials: off, CPA: 1 nm, TCPÄ: 10 min

2. GNSS: Nav
3. Telegraph: Full Ahead
4. Auto-Pilot: On and set on bridge control
5. Radio: Ch 16, Volume 100
6. Charts: 1812, 142, 1912 + pencil, eraser, divider, parallel rulers
7. Echo sounder: switch off

4.2.2 Phase Two: Introduction to Test Subjects

Welcome Procedure

Arrival test subjects

They are only allowed to enter the simulator room as a group by 1330h, so when they are all present. Suggest they should go to the bathroom before we start. Seat them around the briefing table. Welcome and thank them upfront for their presence.

Program and research goals • Self-presentation • This simulation serves as a practical implementation of LOFT on a maritime navigation simulator. • The main goal of this research is to experiment whether LOFT in itself can be translated towards and used in a maritime context. Of lesser importance, we will try to find through qualitative comparison of data from these simulation experiments, that using LOFT for training purposes can be advantageous for technical and -more importantly for this research -non-technical skills. These are more specifically Human Errors like: MRM, (group) communication, problem-solving-ability, information overload and others.
Remarks • This simulation is extracurricular to your AMA study, so your actions here will have no effect whatsoever on your grades. The sole purpose is purely academic and all data is highly confidential. • Since the recording of this simulation will start from the moment of the briefing till the debriefing, I would kindly ask you to turn off your mobile phones or put them in full silence mode as to not disturb the recording or any participant, including yourself. For that same reason, please do not take any other smart device with you inside the Polaris simulator. Thank you for your understanding. • If anyone of you needs to go to the bathroom, now you can still go.

Explain data collection

Video, audio, radar screen and back-play We are interested in your behaviour, actions, communication and problem-solving ability. To assess this on the spot is very difficult, that is why we record so we can analyse everything more profoundly later on. All of the data will be used exclusively for research purposes.
If you have any questions about the data collection, you can ask them now or sent me an email.

Consent of the test subjects

Simulator Research exercise for Master Thesis Nikita Zazulia

I, named ………………………………………………………………. allow Nikita Zazulia to record my voluntary participation in this research -taking place at the Polaris simulator of the Antwerp Maritime Academy on 17/02/2021 -both audio and visually. I agree that this data will be used strictly for research purposes in an academic context, not exclusively, linked to the thesis *Exploring the Implementation of Line Oriented Flight Training on a Maritime Navigation Simulator* under the terms and conditions mentioned hereafter.

I, Nikita Zazulia, will not falsify or abuse these data in any malicious act, I reserve the right to use and distribute it for academic purposes and also possess the right of ownership. My promotor is Professor C. Collard and co-promoter Captain. A. Annaert.

Thank you for your participation.

Nikita Zazulia Signature participant

Date : 24/02/2021

4.2.3 Phase Three: Briefing

In this phase several theoretical topics will be briefly refreshed. These topics are in fact independent courses at the AMA in their own right, for which all of the participants have passed already. Here, only relevant –for the simulation exercise –parts will be discussed.

a) GMDSS (*Global Maritime Distress and Safety System*)

1) Sea Area;

A1, A2, A3 and A4. Each area corresponds to its own set of radio devices; VHF, MF, Inmarsat or HF and HF correspondingly (here, only VHF channel 16 and MF 2182 kHz are relevant).

2) Identification;

Always consists of Name Ship Station + Callsign +MMSI

3) Distress: MAYDAY

A distress call can only be sent if –in the opinion of the captain –the ship or one or multiple person(s) aboard are in dire peril or life-threatening situation AND immediate external help is necessary.

Whenever a distress call is received, all the information contained in the call should be written down in the radio log and the position should be plotted as soon as possible.

4) Urgency: PAN PAN

Only be used for:

Navigational warnings

Meteorological warnings

Medical advice or assistance required

Supporting communication for search and rescue operations

Other urgent information

5) Safety: SECURITE

    Used for:

    Ship-to-ship navigation safety calls

    Ship-reporting communication

    Weather observations destined for an official meteorological service

    All communication concerning ships' navigation, movements, and other needs

6) Acknowledgment:

    Always wait for MRCC to take initiative. If they do not respond, ONLY then, your ship station can acknowledge PLUS send a Mayday Relay. Always follow instructions of a MRCC.

7) Radio Logbook

    The follow should be registered:

    Calls related to distress and SAR situations

    Any malfunctioning GMDSS equipment, as well as the time of reparation

8) ALRS volume V

    This is the Admiralty List of Radio Signals publication which contains all of the legal information and regulation on GMDSS. Everything which has been mentioned hereabove –and much more –can be retrieved from this publication (Hydrographic Office et al., 2020).

b) Bridge Procedures Guide

BPG contains the best navigational practises for commercial ships and principal industry advice on safe bridge procedures (International Chamber of Shipping, n.d.).

The test subjects do not need to read it in full, but the importance is currently hugely underestimated.

Overhaul the chapters and pay special attention to Annex 3 – Checklists. Annex 3 is the most interesting for this simulation. Since there, a good and standardised way for every element of bridge operation is described. Advise the test subjects to have a quick look at the lists themselves. These serve as a procedure towards helping the navigator to deal with all sorts of situations. There are three sections for checklists; A for pilotage, B for the bridge and C for emergency situations.

c) SMCP *Standard Marine Communication Phrases*

There are two main areas where the IMO has intended this standard English phraseology to be used:

a. External communication– ship-to-ship and ship-to-shore communication.
b. Onboard communication– communication within the ship.

These are good guidelines and navigation officers should –when required –use them. The purpose of SMCP is to eliminate miscommunication and misunderstanding, consequently, by doing so increasing overall safety (International Maritime Organization, 2005). Since all of the test subjects are Dutch-speaking, there is no need to speak English on the bridge (onboard communication). However, the test subjects should pay special attention to use correct SMCP when in external communication.

4.2.4 Phase Four: Scenario

Presenting the scenario

- The scenario will take approximately 2 hours
- Ship is on a transatlantic crossing from Norfolk USA towards Tanger port Morocco.
- You take over the watch during the last segment of the voyage, just off the coast of southern Spain.
- The simulation ends when you dock at the RoRo terminal in Tanger.
- The passage plan has already been drawn-up for you on the paper charts.
- All of the navigational equipment on the bridge is active and at your disposal.
- We introduce just one limiting factor; you will not have ECDIS. However, the GNSS (GPS) is active and functional.
- Make sure you are aware of the required port approach and arrival procedures.
- All books and Admiralty Nautical Publications you might require are present on the bridge.

Some arrangements during simulation

All of our devices have to work synchronised; this means we cannot stop the simulation. That is why we ask the following from you:

-do not take any device with you on Polaris.

-you cannot go to the bathroom during simulation

-this is a full-on navigation simulation; this means nobody will be intervening and you cannot ask any questions concerning the exercise.

Ship’s Particulars

Table 8 Ship’s Particulars Experiment Two

Source: Own material

Name	KMSS DAINTY
Callsign	LKAB
MMSI	257125004
LOA	294.1 m
Draught	12.6 m
Breadth	32.2 m
Displacement	76752 t
Propeller	One Fixed Pitch; Right Rotating
Thrusters	One Bow Thruster
Speed at Full ahead	24.9 knots

Allocation of Roles

The roles of Captain, 2nd Officer and Apprentice-Officer are distributed at random by drawing cards. State to the test subjects that regardless of the rank of their given role everyone is responsible for a safe passage. Also, they should divide the bridge duties (look-out, chartwork, radar, manoeuvring, radio-telephony…) according to their own judgment.

Start Bridge Recording

- Video camera
- Microphones
- Back-play

Timeline

Table 9 Timeline Experiment Two

Source: Own material

Time	Event Set	All events	Details
0600	Event Set X: **Pre-Sail**		• Subjects receive 15 min to prepare before start of simulation as part of preparations for taking over the watch.
0600 - 0610	Event Set A: **Change of Watch**	Start simulation Take-over watch	• Position: N 36° 03' W 006° 40' Course: 112° Speed: Full Ahead Radar Echo's: MV Evergreen Sea visibility fine: xxxxx, sea state normal: xxxxx

0610
-
0640
	Event Set B: **Voyage**	Navigation in coastal waters
		Incoming distress message
			• Send message on VHF Ch 16
			  ○ First May Day Call at 0610
			  ○ Second Call at 0615
			  ○ May Day vessel does not reply to incoming calls. Subjects should relay and contact MRCC Tarifa
			    ▪ MRCC Tarifa calls on subjects and instructs them to proceed voyage.

0640 - 0725	Event Set C: **Voyage**	Navigation in coastal water Auto-Pilot breakdown (Tanger Pilot) GNSS No-Signal	• visibility bad: xxxxx, sea state normal: xxxxx; at 0640. • At ±0645, must coincide with avoidance manoeuvre for two vessels crossing from SB! If subjects call on intercom: chief engineer solves issue and informs subjects. • Visibility very bad: xxxxx, sea state normal: xxxxx ; at ±0655 • If subjects report ETA to Tanger, Tanger Pilot answers affirmatively. Should be around 0900, see Int Chart 142. • At 0710; if subjects call on intercom: inform subjects this issue cannot be solved during voyage. Proceed voyage.

0725 - 0800	Event Set D: **Approaching Port**	Port approach Tanger Port Main Engine failure End Simulation	• visibility good: xxxxx, sea state bad: xxxxx; at 0725 • visibility good: xxxxx, sea state very bad: xxxxx; at 0730 • Due to heavy weather Tanger Port calls on subjects informing them to anchor in Anchorage Area nr 3 at 0735. See chart 1912. • Reduce RMP to 50% at 0740. Engine shut-down at 0745. Chief Engineer can fix this issue after request from subjects through intercom. • Simulation ends after subjects have anchored the vessel.

Colour key:

Blue text: Event Triggers

0610: Time of Event Trigger

Xxxxx: Specific setting on the simulator, which corresponds with definition (f.i. visibility good)

Text: Indication that the instructor should execute a Radio Telephony Call at this stage in the simulation, for the exact text see hereunder.

Radio Telephony Calls

Mayday Call

May Day x3

This is MV Denebola x3

Callsign HELP hotel echo lima papa

MMSI 25 71 25 999

Mayday

This is MV Denebola

Callsign HELP

MMSI 257125999

We are in position N 35° 30’ and W 008° 05’

We had an explosion in our engine room, we will abandon ship.

Over

MRCC Tarifa Call

Mayday

Polaris x3

This is Tarifa MRCC x3

Received Mayday Relay

Question what is your position?

Over

Mayday

Polaris

This is Tarifa MRCC

We have found closer stations to Mayday station. You can proceed with your voyage; we will handle the distress situation from now on.

Request pleas acknowledge.

Over

Mayday

Polaris

This is Tarifa MRCC

Have a good voyage.

Out.

Tanger Pilot Answer

Polaris x3

This is Tanger Pilot x3

Your Pilot will be ready for pick-up at 0750. Call again when you are at pilot boarding area. (if requested by subjects, boarding area: 8 cables NNE of the head of the breakwaters).

Pleas confirm.

Over

Polaris

This is Tanger Pilot

Well received. Good voyage.

Out

Tanger Port Call

Polaris x3

This is Tanger Pilot x3

How do you read me?

Over

Polaris

This is Tanger Pilot

Due to adverse weather the pilotage service has been suspended and all port entries have been forbidden until further notice.

Request to anchor in anchorage area number three.

Pleas confirm.

Over.

Polaris

This is Tanger Pilot

That is correct. You can proceed.

Out

Simulator Starting Situation

Figure 8 Simulator Starting Time Experiment Two

Source: Own material

Passage Plan on Charts

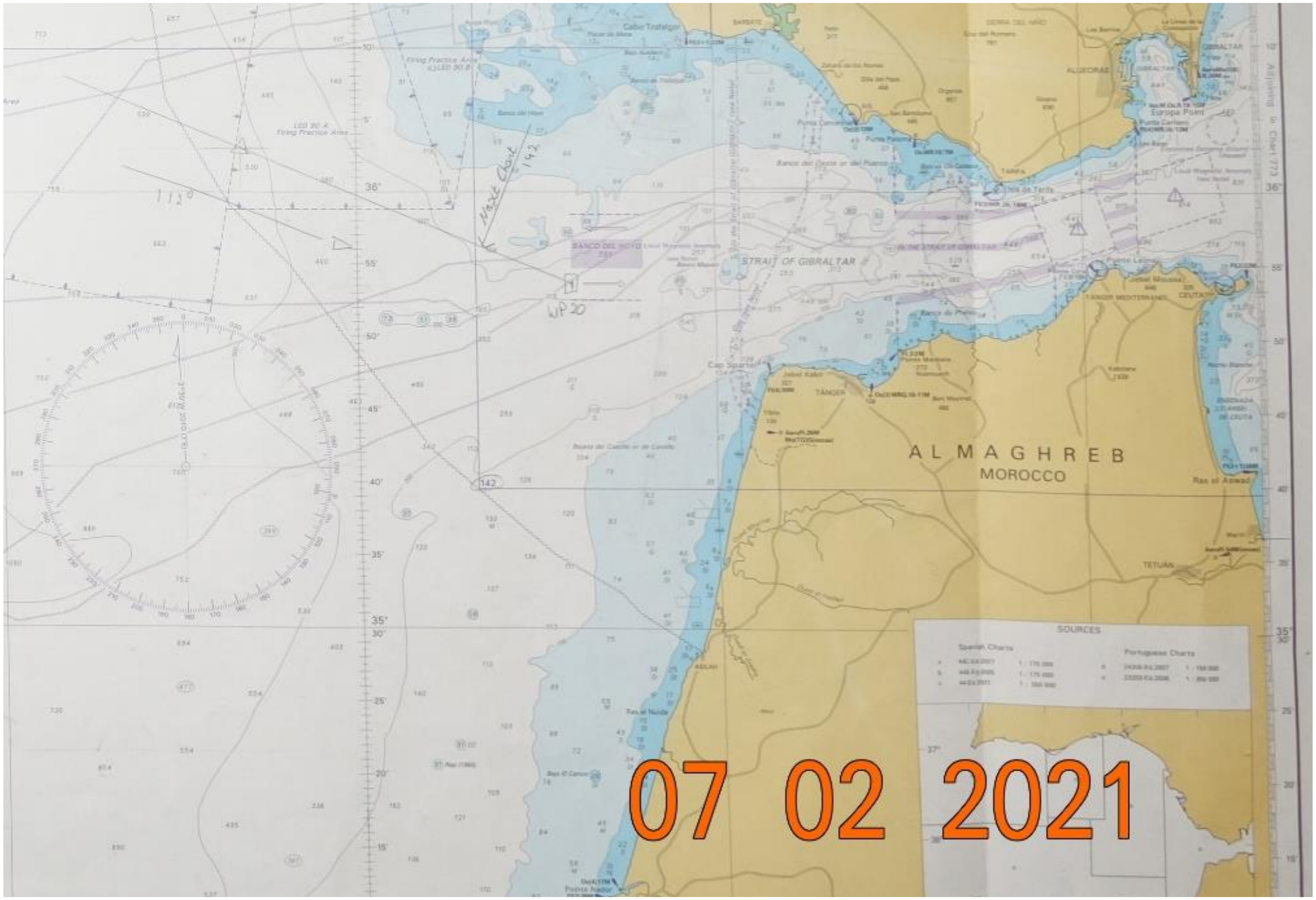

Figure 9 Passage Plan on Charts Experiment Two

Source: Own material

Figure 10 Passage Plan on Charts Experiment Two

Source: Own material

Figure 11 Passage Plan on Charts Experiment Two

Source: Own material

Charts

1st chart: INT 1812= Cabo De São Vincente to The Strait Of Gibraltar.

2nd chart: INT 142= Strait Of Gibraltar

3rd chart: INT 1912= Port De Tanger-Ville

Waypoints

Table 10 Waypoints

Source: Own material

Waypoint 20	N 35° 54’ W 006° 18’
Waypoint 21	N 35° 54’ W 006° 05’
Waypoint 22	N 35° 49’ W 005° 47.3’
Waypoint 23	N 35° 47’3 W 005° 47’3

4.2.5 Phase Five: End Simulation

Debriefing

Stop recording on bridge

- Video camera
- Dictaphone

Debriefing

After the termination of the simulation the test subjects are asked to wait outside the simulator quarters for about 15 minutes. During this time the instructor and the operator reflect jointly on the exercise, in order to align each other's view on the performance and to add final comments on the 'Evaluation Sheet'

The actual debriefing begins when all test subjects are seated in the briefing room. The operator provides feedback on the overall performance and comments on several specific aspects of the navigation. This is facilitated by the use of the operator's screen-recorded back-play, which is projected on a big whiteboard.

Subsequently, the instructor provides feedback according to the LOFT methodology. It is of paramount importance that the instructor facilitates crew participation and creates an open and free atmosphere where there is interaction with the test subjects. This can be achieved by clearly stating that there is generally no entirely right or wrong solution. Remind them that they as a crew have decided upon actions which have determined the outcome and the goal of debriefing is to learn from that process. Trigger the test subject to reconstruct their own actions by asking open questions, the standard evaluation form should be the guideline in this. The use of video playback provides a visual reminder to the test subjects of the specific situation. Help them realise what was a good or bad decision. The focus should lie mainly on the non-technical skills and why or how technical errors were made[43].

[43] The fact in itself that a technical error was made is of lesser importance, look for the origin or the root of the issue.

Break-down

- Thank everyone for participating
- Save all data
- Clear the simulator of all the material.

5 Evaluation

The evaluation is subdivided in two parts or goals. The first one is to improve a specific LOFT session itself. This implies evaluating the scenario details. More specifically, are the Event Sets and Triggers well chose, do they fulfil the intended need, were there any problems, can it be further improved etc. Also, are the created evaluation sheets good, practical, is there need for improvement or not. The briefing and debriefing must also be assessed, were they conducted in the right mind set, has the intended goal been reached, etc. The last paragraph will be dedicated to report on how the test subjects performed during the experiments. This will be done by going through all the Event Sets and Triggers and compare the actual behaviour against the desired one.

The second goal is –to attempt –to conclude or comment on whether the LOFT methodology per se a viable and favourable way of organising simulation exercises in a maritime context is.

5.1 Evaluation of the experiments

5.1.1 The scenario

First the scenario will be discussed. Focus will not lie on how the test subject actually performed, but rather how the scenario design works out. The practicality of the Event Sets and Triggers and how it all fits in the entire simulation.

Overall, the simulation progressed quite well. However, Event Trigger B1 turned out to have a flaw. According to routine GMDSS rules, upon the reception of a distress call any ship-station should listen out and wait for a MRCC to respond as first. Only after an acknowledgement from a MRCC, is the ship-station allowed to act. The catch behind this E.T. was that no MRCC was going to reply to the distress call[44]. The learning goal here is for the trainees to –first –realise that this is a special situation and –secondly –that there are special GMDSS procedures to follow intended for this exact situation[45]. During the first experiment the test subjects failed not only to identify the special GMDSS situation. They completely failed to follow even the routine GMDSS procedures, which are described hereabove. Upon reception of the call, they immediately formally acknowledged the call. Never having waited some time[46] –to at least give any coast station the chance to acknowledge. This is something no ship-station is ever allowed to do[47]. Furthermore, after having plotted the distressed ship-station's position, they immediately changed course and set sail for help. Per se, this is a very humane thing to do, however, it is completely against the rules and regulations currently in force[48].

[44]N.B., this situation is realistic in the sense that if the ship-station in distress used an incorrect radio frequency or radio device to emit the May Day, the MRCC will possibly lie outside the radio action radius. Thus, resulting in the need for your ship-station to relay the original message in order to reach the MRCC. The situation is unusual, but very possible. For that reason, there are special procedures written down in the GMDSS regulations to accommodate this kind of situation.

[45] N.B., this relay situation is part of the GMDSS theoretical course at the AMA and similar situations are covered by the classes provided. So, the test subjects are at least familiarized with this concept.

[46] In theory, this is around five minutes.

[47] If one is to keep strictly to the rules.

[48] From a legal point of view their actions can have dangerous repercussions. By acknowledging the distress call, they have accepted responsibility for the search and rescue of the vessel and people in distress. Substantial insurance claims and lawsuits can be laid upon them for any action taken or not taken. To avoid this, it is paramount to follow the rules and let dedicated organisations –like a MRCC –to assume responsibility.

Nevertheless, the actual flaw in the scenario lies in it that the scripted position of the ship-station in distress is only 35 nautical miles away from the test subject's ship-station. During scripting no considerable thought has been given as to where to position the distressed vessel. The exact position was allocated more or less at random. During debrief the test subjects argued that the distance between them and the distressed ship was only 35 miles and their ship's speed was around 25 knots. So, they could make it in less than 90 minutes and this made it very tempting to simply make with all haste to the rescue. It is still their mistake and distance does not change anything about the rules. Nonetheless, from a scripting point of view it would have been better to locate it far enough as to no longer be that tempting. This, for the sole reason that when they diverted their course, the entire chronological sequence of the script was in peril. By diverting, they lost time which could not be caught up. Meaning that the subsequent Event Sets and Triggers had to be delayed in time accordingly. Fortunately, the operator solved this by reacting quickly. He played the MRCC and instructed them to proceed with the voyage and not to go to help the vessel in distress. Now, we only had to change the upcoming E. T. slightly and the rest could remain as scripted. To avoid this inconvenience for the future simulation session, the position of the vessel in destress had been repositioned to be 80 miles away[49]. The test subjects of the LOFT session handled this E. T. perfectly according to the GMDSS procedures.

Further on, E.T. C1 and C2 showed no problems from a technical point of view. Both test groups made some minor procedural omissions, but nothing substantial. In between these two E. T. during the first simulation session a mistake in communication was made by the operator. The test subject called in at a certain point on Tanger Pilot radio station in order to request a pilot as per regulations. The operator instructed them wrongly that the pilot boarding time will be at 0950 hours instead of 0750 hours. This error was made because during the initial writing of the scenario the starting time for the simulation was arbitrarily chosen to be 0800 hours. And the timing of the scenario progress was made accordingly. E. g., the first E. T. was scripted to occur at 0810 hours.

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[49] The assumption was made that over 3 hours of sailing time would never come across as tempting.

Later, during the Development stage it was discovered that the starting time of the simulation on Polaris is standard pre-set to be 0600h. For reasons of convenience, the decision was made to simply alter al the scripted times in the scenario instead of finding how to alter times on Polaris. This meant that the scripted starting time of 0800 hours and all the following timings had to be altered 0200 hours back in time. E.g., E.T. B1 was to be changed from 0810 to 0610 hours, E.T. C1 from 0845 to 0645 hours and so on for everything. For the final version, in the actual text scripted for the Radio Telephony Calls –from where the operator reads the calls to the test subject –the time correction was not made. This meant that the scripted pilot boarding time was still 0950 hours, but should have been 0750. Subsequently, the test subjects reduced their ship's speed drastically in order not to arrive too early at the boarding position. The operator realised his miscommunication only after a considerable time. A corrective call was sent to the test subject as an ETA update, now with the correct time frame in mind. The test subject when back to full speed ahead, but time was lost. This had to be made up for, by delaying the entire Event Set D. As a corrective measure towards the following simulation session, the time in the text was altered to 0750.

For the final Event Set, a remark from a programming point has to be made. During the final 30 minutes of the scenario –the port approach and entry –the weather is scripted to go very bad. Stormy-like weather impacts the manoeuvrability of the vessel adversely. Even though no issue has been discovered during beta-testing, both test groups failed to anchor the vessel in the dedicated area and crashed or ran aground. They complained that the meteorological conditions rendered the vessel unmanoeuvrable. So, the remark is that the settings for wave hight, wind speed and swell were not ideal to anchor and these settings should preferably have been less severe.

The rest of the elements of the scenario went as scripted, no structural or inherent issue came up.

5.1.2 Briefing

For the first experiment the briefing was straight forward and practical. The only goal was to outline the background information of the scenario[50], provide the test subjects with all the practical knowledge –about the vessel[51] –they need and indicate what this scenario's objective is[52]. Al the explanations and introductions went without a problem and the test subjects confirmed everything to be clear. There were a few minor operational questions concerning the simulator[53], these were cleared out quickly.

The second experiment incorporates a briefing according to the Oxford Aviation Academy Brussels' practice. This way of briefing must be an addition to the LOFT procedures their academy deemed to be beneficial to the overall simulator training courses. Consequently, the first experiment's briefing has been supplemented with theoretical briefing topics. The relevant –for this scenario –topics were thought and explained to the test subjects as scripted. The test subjects encountered no difficulties in following and understanding the explanation. Additionally, they found no irregularities between these explanations and the knowledge they gained from the corresponding courses at the AMA. The only aspect of the topics the test subjects required more explaining about than scripted, was 'May Day Relay'. This piece of theory seemed to be too far away and confusing without additional clarification.

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[50] Port of departure and current position.
[51] Like; vessel's length, breadth, draught, speed, et.
[52] In this case: the arrival at the Port de Tanger's RoRo terminal.
[53] Like; which device to use on the bridge as the ship's own intercom, et.

5.1.3 Debriefing

The first experiment's debriefing went according to the script and much like it is consistently performed at the AMA. A few technical errors were discussed, most of which were violations of the Colregs. The actual evaluation of the test subject's performance will be conducted in part 5.2 of this part of the thesis.

The second experiment had a LOFT based debriefing scripted. The operator provided his part of the feedback in the same fashion as for the first experiment. The instructor on his turn provided a debriefing with the LOFT methodology in mind. Here, difficulties arose in creating an open and free atmosphere, where the test subjects should feel to be on the same level as the instructor. The instructor was aware of it that creating this kind of setting would be fundamental to facilitate participation –as described in Part 1 of this thesis. However, following the steps mentioned in the script proved to be harder and by far less intuitive as initially anticipated. The instructor did not succeed in convincing the test subject that this debriefing is meant to be a learning process instead of a pure moment of evaluation. Asking open questions proved not to be –sufficient –enough to trigger the test subjects to reconstruct their events and actions themselves. Additionally, it was clear that combining all of these efforts in combination with the standard evaluation form, made it too difficult and arduous to the instructor[54]. Over-all, no substantial crew participation and interaction was achieved. Contrary, the instructor did manage to press the focus on non-technical skills. Though mainly fruitless, some of the open questions –about errors or mistakes –towards the test subject did trigger an open discussion and mild interaction. Thus, some modest learning might have been achieved on a limited number of topics discussed. Conclusively, the debriefing meant to have been conducted according to the LOFT methodology did not fulfil or meat –in every aspect – the required standard[55].

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[54] The instructor –who is the writer of this thesis –for our experiments is by no means professionally trained to conduct LOFT-based scenarios and trainings.

[55] As set out in the theory.

5.1.4 Evaluation forms

All the evaluation forms and sheets were composed according to existing practises in the aeronautical industry. This standardised manner of evaluation was only utilised for the second experiment. As mentioned in the previous paragraph the instructor is not professionally trained. As a result thereof, evaluating the test subjects was challenging. The lack of practical experience made it increasingly difficult to keep combining all the forms[56] simultaneously and at the mean time keeping track of the test subject's performance. Notwithstanding, the forms deliver indeed a quite objective and standardised way of evaluating[57]. The clear stipulations of how every behaviour can be recognised and explicit demarcations of what exactly is expected of the trainee to deliver with the corresponding assessment and training topics, are a good evaluation guide for the instructor. However, some practical remarks are to be made; constantly switching between the three different sets of evaluation sheets is impractical, especially because the instructor's desk inside the simulator was too small; the comment section of the 'Training Module Evaluation Sheet' had insufficient writing space for several topics, these should have been made bigger.

[56] 'Core Competencies and Behavioural Indicators', 'Assessment and Training Matrix' and 'Training Module Evaluation Sheet'.

[57] Provided the instructor is fluent, experienced and familiarised enough.

During the experiment, an intuitive deficiency has been detected in the 'Assessment and Training Matrix' and –linked to it –the 'Training Module Evaluation Sheet'. Some test subject's actions were erroneous or insufficient, while at the same time these had nothing to do with any particular assessment and training topic –part of said matrix. This resulted in the evaluation sheet not being provided with a topic dedicated to generic non-compliances, where the instructor could register a comment. Said actions were observed to be clear violations or errors and thus must be systematically addressed –for the purposes of evaluation and training progress. Unfortunately, because they do not link-up with any specific topic included in the matrix and evaluation sheet, these could not be included in the evaluation of the test subjects. Resulting in the instructor feeling an intuitive deficiency to both forms. This issue was addressed during the evaluation phase by appending an additional assessment and training topic to both the matrix and the evaluation sheet, namely, "Compliance". This topic was later found to be already included in the EBT manual, which was used as guide in creating the matrix. This meant that it could be easily added and made match the standard format already in use.

5.1.5 Presenting the test subject's performance

For the purposes of this research one scenario was used on two separate test groups. The first experiment was performed with the control group, the second with the treatment group. The performance will be presented for each experiment chronologically according to the Event Sets and other relevant elements that occurred. Only aspects that took place during the scenario will be discussed here. The other aspects[58] of each experiment already have been discussed in the sub-paragraphs hereabove. What follows are the transcriptions of the test subjects' actions during the simulation, it is not an evaluation.

[58] Those being 'Briefing', 'Debriefing' and 'Evaluation forms'.

5.1.5.1 First experiment

Table 11 Report Experiment One

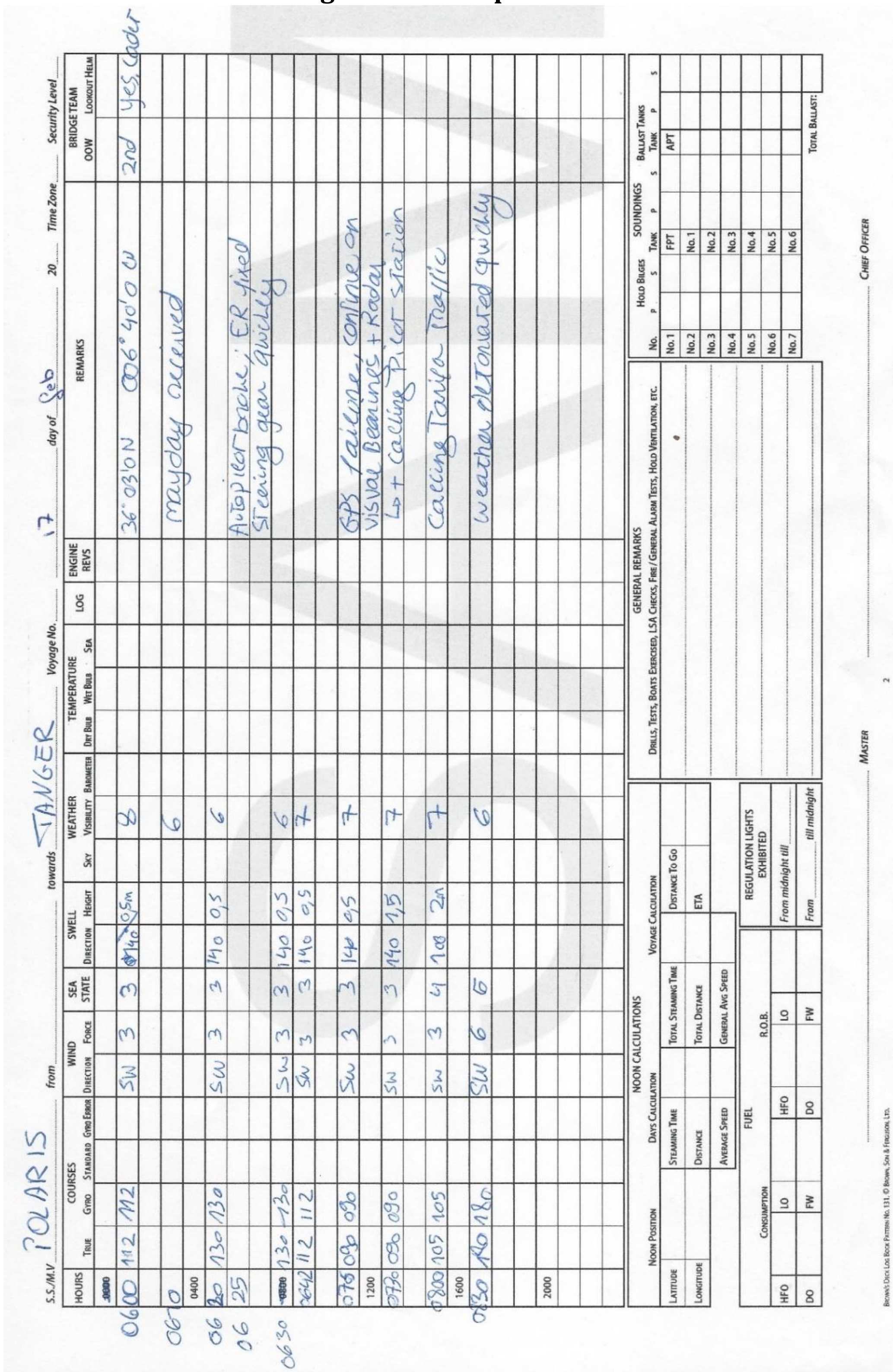
Source: Own material

Event	Performance
Equipment check	The test subjects followed the steps of the BPG, checklist B6 during the preparation time.
Familiarisation passage plan	The passage plan drawn on the paper charts was examined. The current position was compared to the next waypoint, as a preparation.
Deck logbook	It was well filled in at short intervals and whenever some issue arose. However, they forgot to report about the engine breakdown.
Navigation in coastal waters	Checklist B10 of the BPG was not consulted. Still, overall performance sufficient. Only minor elements were missed or forgotten.
Engage collision avoidance according to Colregs	Both radars were set correctly and traffic's radar echoes were tracked. Visual lookout well performed. The course changes executed as part of collision avoidance were multi-stage and very small. Sound signals were not engaged when necessary regarding restricted visibility. These are a violation of the Colregs.
May-Day call	Designated checklist in BPG was not consulted. Contents of distress alert was well recorded. Position of distressed vessel plotted on the chart. Initially the correct discission was made to not call back and wait, but for the wrong reason. The captain and 2nd officer were waiting for the cadet to calculate ETA and heading towards distress position. After the may day call was repeated –by which time the cadet made his calculations –they called on the distressed vessel and single-handedly decided to go for the rescue. This is a clear violation of the GMDSS regulations.
Restricted visibility due to rain and mist	The test subjects made no alterations or preparations because of the restricted visibility, only the fog lights were engaged. The designated

	checklist of the BPG was not consulted and as a result many procedures were missed.
Auto-pilot and steering gear breakdown	The designated checklist of the BPG was not consulted. However, several procedures were performed, like informing engine room, disengaging auto-pilot, engine was slowed down, Not Under Command lights were put on. Still, some were missed.
Auto-pilot or steering gear breakdown; manual steering	After auto-pilot breakdown, manual steering was engaged. Manual steering performance was to standard.
Communication with pilot station	The communication met the SMCP standard. However, numbers were often communicated in full instead of digit by digit as requested by the regulations.
Loss of GNSS signal	Alarm was acknowledged and the captain immediately decided to initiate manual position fixing. The decision was not made to decrease the position taking interval, it is good practise to increase the amount of positions taken.
Loss of GNSS signal; manual position fix	Position fix through radar bearing and distance towards a fixed charted point was initiated immediately. After 50 minutes visual bearings were used as well.
Heavy seas due to wind, waves and swell	The test subjects made no alterations or preparations because of the heavy seas. Consequently, they did not consult the designated checklist of the BPG and missed out many procedures. When they entered a mist bank, the fog sound signal was initiated.
Port approach in heavy seas and Restricted visibility	Local regulations on port approach were consulted in the correct publications and complied to them accordingly. General pre-arrival checklist of the BPG was not consulted. Consequently, several procedures were missed out. Preparations for anchoring were requested to the bosun by the captain.

Main Engine Failure	The test subjects realised the engine breakdown after five minutes. The designated checklist of the BPG was not consulted and many procedures were missed out. A routine radio call was made towards Tarifa Traffic informing them of the breakdown. Procedurally it should have been at least a safety call and destined towards Port de Tanger.
Anchoring in sea-anchorage	Test subjects crashed the vessel into the breakwaters of the port. Here the simulation ended.

Logbook first experiment



S.S./M.V POLARIS from towards TANGER Voyage No. 17 day of Feb 20 Time Zone Security Level

HOURS	COURSES TRUE	COURSES GYRO	WIND DIRECTION	WIND FORCE	SEA STATE	SWELL DIRECTION	SWELL HEIGHT	WEATHER VISIBILITY	REMARKS	OOW	LOOKOUT HELM
0600	112	112	SW	3	3	140	0,5m	8	36°03'0N 006°40'0W	2nd	yes, Cader
0610								6	mayday received		
0620	130	130	SW	3	3	140	0,5	6			
0625									Autopilot broke; ER fixed steering gear quickly		
0630	130	130	SW	3	3	140	0,5	6			
0642	112	112	SW	3	3	140	0,5	7			
0706	090	090	SW	3	3	140	0,5	7	GPS failure, continue on visual Bearings + Radar		
0730	090	090	SW	3	3	140	1,5	7	Lo + calling Pilot station		
0800	105	105	SW	3	4	100	2m	7	calling Tarifa traffic		
0820	180	180	SW	6	6			6	weather deteriorated quickly		

Figure 12 Logbook Experiment One

Source: Own material

5.1.5.2 Second experiment

Table 12 Report Experiment Two

Source: Own material

Event	**Performance**
Equipment check	Designated checklist in BPG was consulted. All the equipment was checked and set correctly.
Familiarisation passage plan	The passage plan was consulted and analysed by the test subjects jointly. The correct chart was laid out, ready to be used. The port pre-arrival procedures were consulted in the ALRS.
Deck logbook	The logbook was filled in at short intervals, but only the bare minimum has been reported[59]. They forgot to report about the engine breakdown.
Navigation in coastal waters	Checklist B10 of the BPG was not consulted. Several minor elements were missed. Overall performance satisfactory: position fixed regularly, effects of weather and current discussed, et.
Engage collision avoidance according to Colregs	Both radars were set correctly and traffic's radar echoes were tracked. Visual lookout well performed and cross-checks were performed with radar readings. Correct evasive manoeuvres according to the Colregs regulations were executed. However, the first starboard manoeuvre was not a big enough of a course change and was not performed in a timely manner. An additional course change to starboard was executed to make up for that error.
May-Day call	Designated checklist in BPG was not consulted. Content of distress message was recorded. Distress position was plotted on the chart immediately. ALRS volume V was consulted by the captain to lookup the Sea Area. Distress sea area was correctly established to be A2. After first call, radio watch was maintained. After second distress call, correct GMDSS procedures were looked up in the ALRS volume V. A

[59] Only the major events were included, like steering gear failure.

	may day relay call was completed by the captain. Communication with the MRCC was established. End of may day situation.
Restricted visibility due to rain and mist	The test subjects have not noticed the restricted visibility at all. Only the word "fog" is recorded in the logbook. Consequently, the designated checklist in the BPG was not consulted and no procedural alterations or preparations were made.
Auto-pilot and steering gear breakdown	The designated checklist of the BPG was not consulted. The second officer immediately disengaged the auto-pilot and switched over to manual steering. The captain informed the engine room. Nearly all the procedures were not followed, some of which were important[60]. After a while, the vessels in the vicinity were checked and the second officer suggested to reduce the speed as a safety measure. By the time the captain agreed, the steering gear was already fixed.
Auto-pilot or steering gear breakdown; manual steering	After auto-pilot breakdown, manual steering was engaged. Manual steering performance was to standard.
Communication with pilot station	The communication met the SMCP standard. However, the position was always given in latitude and longitude in stead of relative bearing and distance. When the pilot de Tanger requested ETA, the test subjects did not do the calculation upfront and had to do it on spot. These are not errors as such, but inconveniences.
Loss of GNSS signal	First the alarm was acknowledged by the cadet and the information was not reported to the captain or second officer. After one minute the cadet reported the alarm to the captain. Crosschecks were done between the gsp-unit and the radar, to check whether the radar still had gps-signal. The decision was made to start taking radar bearing

[60] F.i. enabling the Not Under Command lights and sound signals, broadcasting a safety message to inform the nearby vessels, modify AIS, …

	and distance for position fixing purposes. They did never realise that when the gps-unit loses signal, all connected devises switch automatically towards deadreackon[61]. The position taking interval was not reduced[62]. After 30 minutes the captain decides to call the on board "automation officer", who informed them that the gps issue can not be solved during this voyage. From which they concluded that –as supposed –the gps-position on the radar cannot be trusted.
Loss of GNSS signal; manual position fix	Immediately, the decision was made to plot the position on the chart based only on radar bearing and distance. They never took a visual bearing.
Heavy seas due to wind, waves and swell	The test subjects realised they were in heavy seas. They did not consult the designated checklist in the BPG and missed out many procedures. During the last part, the captain decided –because of the bad weather –to decrease engine speed to half ahead. This was done to ameliorate the manoeuvrability.
Port approach in heavy seas and Restricted visibility	The first ETA provided by the captain to Pilot de Tanger could not be made anymore, because of circumstances they had to slow down and lost time. The test subjects failed to send an ETA update to the pilot station. A new ETA was calculated only after a direct request from the pilot station. General pre-arrival checklist of the BPG was not consulted. Consequently, most procedures were missed out. They checked whether the directed anchorage area was fit for this ship to anchor in –dimension wise.

[61] F.i. the radar automatically switches towards guessing the position based on current speed and course, this is only an estimation.
[62] They did not start to take more positions. Even though, the realisation was made that manual position fixing is of vital importance when there is no gps-signal.

Main Engine Failure	Accidentally the engine breakdown occurred at the same time the captain decided to reduce engine speed to half ahead[63]. Consequently, the engine breakdown was never observed.
Anchoring in sea-anchorage	During the last part, less and some erroneous position fixes were made. Consequently, the test subjects had no correct idea of their position. They were closer to the shoreline than they thought. Together with the loss of RPM or speed, the vessel rendered unmanoeuvrable. Finally, they run aground on the shore close to the port of Tanger. A may day call was made by the captain. After this the simulation was ended.

[63] Since both actions result in a reduction of RPM, the test subjects could not know the subsequent reduction in speed was due to a breakdown and not their telegraph command. On top of that, the bad weather made this situation even more unclear.

Logbook second experiment

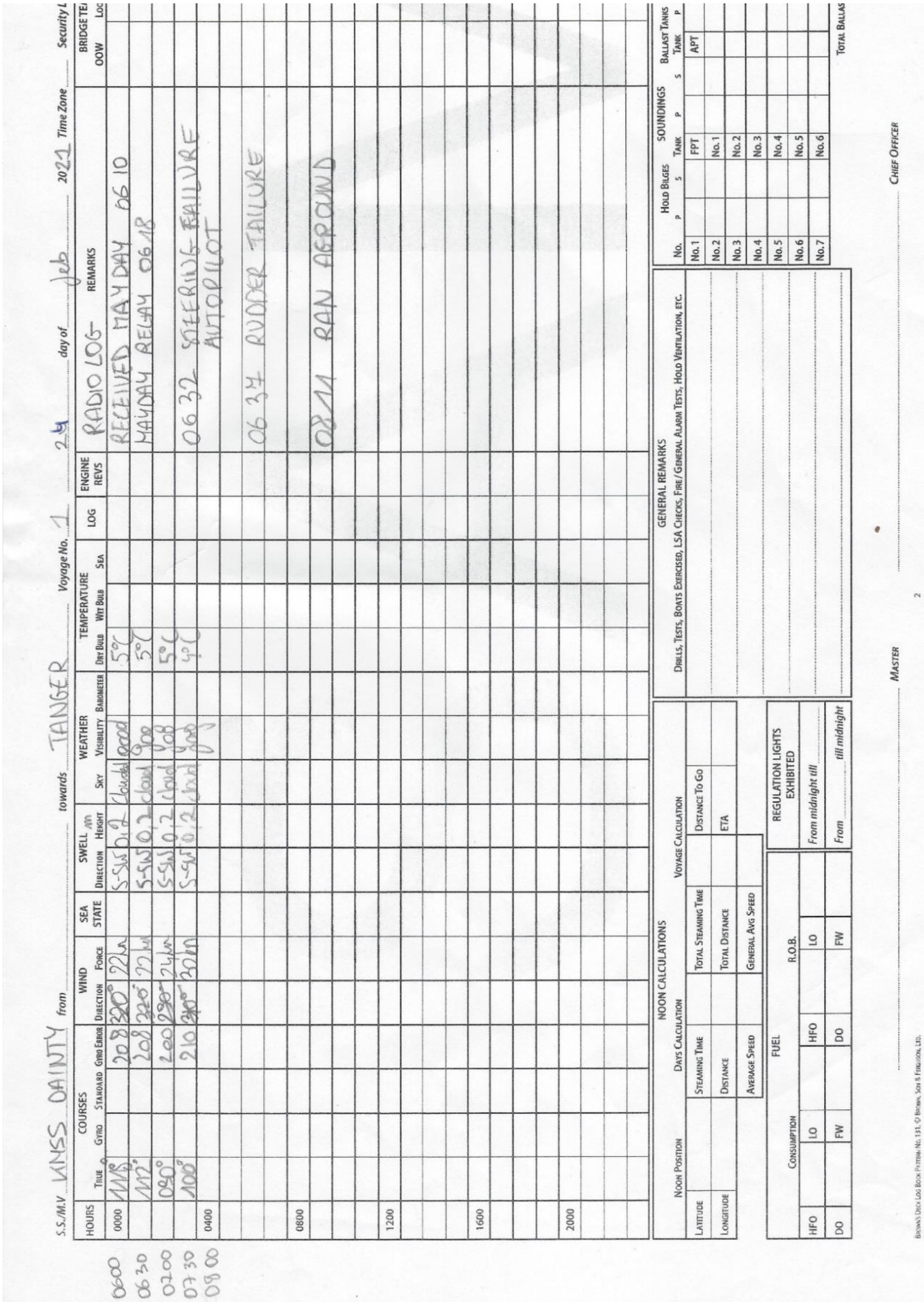


Figure 13 Logbook Experiment Two

Source: Own material

5.2 Evaluation of LOFT

The study's emphasis is exploring the implementation of LOFT methodology in the maritime sector. It is not the goal of this thesis to prove or disprove the effectiveness of LOFT for this sector. Most importantly, to consider any such statement to be scientifically significant, an array[64] of scenarios should be developed and each of these should be experimentally tested. Additionally, every single one of them should be conducted against a control group as well as a treatment group –for comparison purposes. This would require making the empirical testing of this thesis exponentially more extensive. For this research that was unattainable and thus discarded. Consequently, evaluating the actual test subject's performance –even more so comparing –is of limited importance for this study. Not only because of the limited scientific relevance[65], most importantly it is simply not the goal. What follows is a discussion of how attainable switching to LOFT for simulator classes is and what difficulties were encountered during the experiments for that matter.

5.2.1 Theoretically

From a theoretical point of view every aspect of LOFT can be translated towards the maritime industry, except for one. When considering every description of the building blocks[66] towards the creation of a true LOFT simulation session, by changing the intendent goal group from the aeronautical simulator classes towards the maritime simulator classes the same building blocks and principle are applicable.

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[64] The more scenarios and experiments are conducted, the more the results are representative and scientifically valuable.

[65] Only one scenario was used.

[66] Which have been elaborately discussed and developed over the chapters of this part of the thesis.

The methodology and the standard lists already in place for flight simulator sessions are – with alterations when necessary –readily applicable on navigation simulators. E.g., the list 'Core Competencies and Behavioural Indicators' is relevant and fitting for both aeronautical as well as maritime purposes[67]. The only alteration required for this particular list is changing industry specific phraseology, like "Aircraft Flight Path Management" becomes "Vessel Sail Path Management". The content of the accompanying competency description and behavioural indicator are applicable to both industries.

The remark must be made that 'applicability' does not intrinsically mean 'the best fit'. The aforementioned list comes from the EBT manual, elaborate and specific research has been conducted by the authors to device that list. Their goal was to make this list fit the aeronautical needs the best. Thanks to the many similarities between the two industries, translating from one towards the other keeps the information relevant or applicable –to some extent. However, to be scientifically correct, we –in the maritime industry –should conduct our own research on every aspect to find our 'perfect fit'. Nevertheless, for this study and as a first step towards standardisation and try-out of LOFT, it is acceptable and relevant enough to only conduct translations. To be strictly scientific, the translation of each topic merits dedicated research[68] to find the perfect fit for maritime purposes. Only then a scientific meaningful conclusion can be made whether f.i. a list is truly applicable or not, after all. As for this research, we chose to translate and follow the LOFT methodology as precisely as possible.

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[67] This is evident when both versions –the original aeronautical and the translated maritime version –are read next to each other. See Table *4* Core Competencies and Behavioural Indicators and Annex B for the original.

[68] This cloud be part of a possible future stadium of exploring LOFT in the maritime industry.

Using this method of translation, as demonstrated in this part of the thesis, LOFT can be applied on a maritime simulator. However, the Job Task Analysis, an essential part of creating a scenario –in a standardised way –could not be translated directly. The existing JTA lists contain too specifically aeronautical scenarios and learning objectives, which are in most part irrelevant or not –as such – applicable to the maritime navigation simulator. Ideally, an extensive JTA list should be devised with very specific and standardised scenario possibilities and learning objectives for the maritime navigation simulator in mind. Doing that would require a dedicated research on finding out, categorising, testing and revising the specific learning goals. This would fall outside the scope of this thesis, consequently, the alternative solution was chosen[69]. The method of creating the objectives from scratch and then fit them in the correct place in the matrix has proven to be arduous, but workable. By trying to fit in maritime objectives in their well-researched list, we could keep their definitions of the 'Descriptions' and 'Desired Outcomes. If any future LOFT scenarios are developed, those objectives can similarly be introduced in the same matrix developed for this research. Over time this would create a JTA for the maritime simulator exercises. However, the current JTA contains only the objectives used for the scenario used in this research.

[69] As discussed in the theoretical part of this thesis; normally, objectives –puzzle pieces –are taken from the JTA –box of puzzle pieces –and put together to form an entire scenario –a full puzzle. In this case, objectives that could fit in the scenario were first created and then placed in the list to form the JTA. The EBT manual's 'Assessment and Training Matrix' was chosen as example to create our own JTA. This because, the matrix form makes it transparent and it is standardised –which is essential to facilitated future enlargements of our JTA.

5.2.2 Practically

Introducing LOFT to the maritime simulator is practically possible, given that several alterations are made. Essentially three 'functions' are required to conduct a LOFT simulation session, namely; simulation operator, instructor and evaluator[70]. *Nota bene*, that Polaris at the AMA is built in such a way that the operator's control panel is located outside the simulator room[71]. Consequently, this produces an awkward situation where the instructor-evaluator –one person –cannot operate the simulator during the scenario, because he must be inside the simulator room with the trainees. For our LOFT session this issue was solved by introducing a person in charge for the operation of the simulator –at the central control panel –and another one for instructing and evaluating. The instructor –which is also the evaluator –conducted the briefing and debriefing and witnessed first-hand how the test subject performed during the scenario. The operator was in charge of making sure everything in the timeline of the scenario was executed at the scripted time. In doing so, the practical issues are overcome.

Another element is the performance of the instructor-evaluator. It is in LOFT an obligation for the instructor-evaluator to be certified (Federal Aviation Administration, 2015, p. 29), this ensures that he is qualified and delivers an indisputable performance –in line with the LOFT mind-set. In the aeronautical industry dedicated courses exist –provided by independent companies or agencies –to become said certified instructor-evaluator. This kind of certification simply does not exist in the maritime world. Something equivalent –for maritime purposes –could be researched for, in order to create that kind of standard.

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[70] N.B., customarily the three functions are combined in one single person, usually called the instructor –for simplicity reasons. Meaning that one person takes it upon himself to operate the simulator, instruct the trainees and evaluate them at the end of the session.

[71] This has been constructed like that, because there are in fact five simulators –Polaris, Altair, Bellatrix, Capella and Sirius –connected to the same central operator's control panel.

However, the question which must be asked, is whether this way of doing a LOFT session is practically feasible to do at the AMA[72]. In the ideal situation, for each LOFT session would be required: one fully scripted scenario, one instructor-evaluator per simulator and one[73] simulation operator. Alternatively, the briefing could be conducted by one single person for all the trainees –allocated to the five simulators –, only if all simulators attend to the same scenario. This implies the need for at least six persons of staff for every LOFT session, as oppose to two or three –currently in use.

It falls outside the scope of this thesis to prove whether LOFT is indeed a superior method of doing simulation sessions. However, this thesis does demonstrate that if chosen to –for whatever reason –LOFT can be applicable for maritime simulation sessions. Notwithstanding this, a great deal of research still remains to be conducted on the implementation of LOFT on a maritime simulator.

[72] Or any maritime academy.

[73] That is if one operator can handle five simulators. Additionally, a second operator could join, if need be. Since the central operator's control panel has been constructed in double.

Conclusion

The goal of this thesis was to initiate the first ever scientific and empirical exploration on implementing Line Oriented Flight Training on a maritime navigation simulator. The emphasise here lies on the word ‘exploration’, because the thesis is just the very first step towards the –possibly –full application of this methodology in maritime training facilities. From that perspective and on the basis of the theoretical and empirical research, this thesis concludes that LOFT can indeed be translated and implemented for training purposes on maritime navigation simulators.

Chapter 5.2 Evaluation of LOFT, Part Two of this thesis provides an elaborate and fully detailed discussion on the results and conclusions of this thesis. The essentials are summarised hereafter.

The theoretical research shows that when the detailed LOFT procedures are approached from a maritime perspective, it is clear that the fundaments are mostly relevant and of interest as much for maritime purposes as they are for aeronautical. In practise, this meant that the procedural instructions provided –not exclusively –by the Instructional Systems Development on LOFT could be meticulously followed to write our own scenario. However, some of the more specific procedures or standardised lists were not directly applicable. To resolve these issues, operational practises in place at the CAE Oxford Aviation Academy Brussels –some of which originate from the Evidence Based Training methodology –were consulted, applied and translated to fit our needs –where necessary.

However, all these ‘translations’ merit dedicated scientific research, to find what specific practise matches maritime needs precisely. Unfortunately, this was unattainable within the scope of this thesis.

The empirical testing revealed that it is practically possible to conduct a LOFT session, without the need for structural alterations to the navigation simulator. A few organisational adjustments –concerning the rearrangement of staff --are required, but nothing of vital importance.

The Recurrent Training type of LOFT was chosen for the creation of the scenario for this research. The knowledge and data obtained from this study could be useful for future research projects. More specifically, the standardised lists that have been translated, are now readily applicable for maritime purposes. Also, the philosophy behind LOFT has been provided with a clear and specific maritime perspective. A suggestion is to develop a Qualification Training type of LOFT. This would encompass the creation of an entire training programme with multiple scenarios. Another suggestion is to continue where this thesis ended. More precisely, to research whether LOFT is indeed a superior method of doing simulation sessions compared to non-standardised methods. Both of which might have evolutionary –if not revolutionary –implications on simulation trainings and thus are of interest to maritime academies.

As a finalising statement this thesis humbly concludes that LOFT is intrinsically suited for maritime simulation purposes. However, much more research and empirical testing is required to make the full implementation a practical reality and to convince the maritime industry of its benefits.

Bibliography

Arthur Jr., W., Bennett Jr., W., Stanush, P. L., & McNelly, T. L. (1998). Factors That Influence Skill Decay and Retention: A Quantitative Review and Analysis. *Human Performance*, *11*(1), 57–101. https://doi.org/10.1207/s15327043hup1101_3

Barnett, M., Gatfield, D., & Pekcan, C. (2004). *A research agenda in Maritime Crew Resource Management.* National Maritime Museum Conference on 'Safer Ships, Safer Lives', London.

Barshi, I. (2015). From Healy's Training Principles to Training Specifications: The Case of the Comprehensive LOFT. *The American Journal of Psychology*, *128*(2), 219–227. JSTOR. https://doi.org/10.5406/amerjpsyc.128.2.0219

Butler, R. E. (1993). LOFT: Full-mission simulation as Crew Resource Management Training. In *Cockpit resource management* (pp. 231–263).

Chidester, T. R. (1993). Critical issues for CRM training and research. In *Cockpit resource management* (pp. 315–336).

Childs, J. M., & Spears, W. D. (1986). Flight-Skill Decay and Recurrent Training. *Perceptual and Motor Skills*, *62*(1), 235–242. https://doi.org/10.2466/pms.1986.62.1.235

Curtis, M., & Jentsch, F. (2019). Line Operations Simulation Development Tools. In *Crew Resource Management* (pp. 323–341). Elsevier. https://doi.org/10.1016/B978-0-12-812995-1.00011-7

Dick, W., & Carey, L. (1990). The systematic design of instruction 3rd ed. *Includes Bibliographical References: USA*.

Dismukes, R. K., Jobe, K. K., & McDonnell, L. K. (1997, March). *LOFT Debriefings: An Analysis of Instructor Techniques and Crew Participation*. NASA Technical Memorandum, California.

Federal Aviation Administration. (2015). *Flightcrew Member Line Operational Simulations: Line-Oriented Flight Training, Special Purpose Operational Training, Line Operational Evaluation*. U.S. Department of Transportation.

Flin, R., Martin, L., Goeters, K.-M., Hörmann, H.-J., Amalberti, R., Valot, C., & Nijhuis, H. (2003). Development of the NOTECHS (non-technical skills) system for assessing pilots' CRM skills. *Human Factors and Aerospace Safety*, *3*(2), 97–119.

Hamman, W. R. (2010). Line Oriented Flight Training (LOFT). The Intersection of Technical and Human Factor Crew Resource Management (CRM) Team Skills. In *Crew Resource Management*. Elsevier.

Hayward, B. J. H., Lowe, A. R., & Thomas, M. J. W. (2019). The Migration of Crew Resource Management Training. In *Crew Resource Management* (pp. 421–447). Elsevier. https://doi.org/10.1016/B978-0-12-812995-1.00015-4

Helmreich, R., Klinect, J., & Wilhelm, J. (2003). Managing threat and error: Data from line operations. In *Innovation and consolidation in aviation*.

Helmreich, R. L., & Foushee, H. C. (1993). Why crew resource management? Empirical and theoretical bases of human factors training in aviation. *Cockpit Resource Management.*, 3–45.

Helmreich, R., Wilhelm, J., Kello, J., Taggart, W., & Butler, R. (1991). *Reinforcing and evaluating crew resource management: Evaluator/LOS instructor reference manual.*

Hydrographic Office, Beale, G., & Great Britain. (2020). *Admiralty list of radio signals. Vol. 5, Vol. 5,*. United Kingdom Hydrographic Office.

International Air Transport Association. (2011). *Evidence Based Training*. International Civil Aviation Organization.

International Chamber of Shipping. (n.d.). *Bridge Procedures Guide*. Retrieved 22 March 2021, from https://publications.ics-shipping.org/single-product.php?id=2

International Civil Aviation Organization (Ed.). (2013). *Manual of evidence-based training* (1. ed). International Civil Aviation Organization.

International Maritime Organization (Ed.). (2005). *IMO Standard marine communication phrases: With pronunciation guide on CD-ROM*. IMO.

Jensen, R. S. (1989). *Aeronautical decision making-cockpit resource management*. SYSTEMS CONTROL TECHNOLOGY INC ARLINGTON VA.

Kanki, B. G. (Ed.). (2010). *Crew resource management* (2. ed). Academic Press.

Kanki, B. G., Anca, J. M., & Chidester, T. R. (Eds.). (2019). *Crew resource management* (Third edition). Academic Press.

Klein, G. (2008). Naturalistic Decision Making. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *50*(3), 456–460. https://doi.org/10.1518/001872008X288385

Lauber, J., & Foushee, H. (1981a). *Guidelines for line-oriented flight training: Vol. Vol. 1*. NASA: NASA Ames Research Center.

Lauber, J., & Foushee, H. (1981b). *Guidelines for line-oriented flight training: Vol. Vol. 2*. NASA: NASA Ames Research Center.

Mager, R. (1984). Preparing instructional objectives (revised 2nd edition). *Belmont, CA: Pitman Management and Training*.

Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement*, *42*(5), 34–36. https://doi.org/10.1002/pfi.4930420508

Page, R. (2000). *A brief history of flight simulation.* Simulation Industry Association of Australia.

Salas, E., Priest, H. A., Wilson, K. A., & Burke, C. S. (2006). Scenario-Based Training: Improving Military Mission Performance and Adaptability. *Military Life: The Psychology of Serving in Peace and Combat: Operational Stress, Vol. 2*, 32–53.

Salas, E., Wilson, K. A., Lazzara, E. H., King, H. B., Augenstein, J. S., Robinson, D. W., & Birnbach, D. J. (2008). Simulation-Based Training for Patient Safety: 10 Principles That Matter. *Journal of Patient Safety*, *4*(1). https://journals.lww.com/journalpatientsafety/Fulltext/2008/03000/Simulation_Based_Training_for_Patient_Safety__10.2.aspx

Scala, F. (2020, October 6). *How does the CAE Oxford Aviation Academy Brussels—Sabena Flight Academy conducts simulation-based training and how Line Oriented Flight Training is put to practise.* [Personal communication].

Seamster, T. L., Hamman, W. R., & Edens, E. S. (1995). *Specification of observable behaviors within LOE/LOFT event sets*. 663–668.

Wahren, E. (2007). *Development of BRM training at SAS Flight Academy.*

Annexes

Annex A

Annex B

Annex C

Annex D

Annex A

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							Competency map							
Manoeuvres training phase	Rejected take-off	A	TO	Engine failure after the application of take-off thrust and before reaching V1	Demonstrate manual aircraft control skills with smoothness and accuracy as appropriate to the situation Detect deviations through instrument scanning Maintain spare mental capacity during manual aircraft control Maintain the aircraft within the flight envelope Apply knowledge of the relationship between aircraft attitude, speed and thrust	From initiation of take-off to complete stop (or as applicable to procedure)	x			x				
	Failure of critical engine between V1 & V2	A	TO	Failure of a critical engine from V1 and before reaching V2 in lowest CAT I visibility conditions		The manoeuvre is considered to be complete at a point when aircraft is stabilised at normal engine-out climb speed with the correct pitch and lateral control, in trim condition and, as applicable, autopilot engagement	x			x				
	Failure of critical engine between V1 & V2	B	TO	Failure of a critical engine from V1 and before reaching V2 in lowest CAT I visibility conditions		The manoeuvre is considered to be complete at a point when aircraft is stabilised in a clean configuration with engine-out procedures completed	x			x				
	Emergency descent	C	CRZ	Initiation of emergency descent from normal cruise altitude		The manoeuvre is considered to be completed once the aircraft is stabilised in emergency descent configuration (and profile)	x		x	x				
	Engine-out approach & go-around	A	APP	With a critical engine failed, manually flown normal precision approach to DA, followed by manually flown go-around, the whole manoeuvre to be flown without visual reference		This manoeuvre should be flown from intercept to centreline until acceleration after go-around. The manoeuvre is considered to be complete at a point when aircraft is stabilised at normal engine-out climb speed with the correct pitch and lateral control, in trim condition and, as applicable, autopilot engagement* (describe generally critical part of manoeuvre)	x			x				
	Go-around	A	APP	Go-around, all engines operative		High energy, initiation during the approach at 150 to 300 m (500 to 1000 ft) below the missed approach level off altitude	x		x	x				
	Go-around	A	APP	Go-around, all engines operative followed by visual circuit, manually flown		Initiation of go-around from DA followed by visual circuit and landing	x		x	x				
	Go-around	A	APP	Go-around, all engines operative		During flare/rejected landing	x		x	x				
	Engine-out landing	A	LDG	With a critical engine failed, normal landing		Initiation in a stabilized engine-out configuration from not less than 3 NM final approach, until completion of roll-out	x			x				

Figure 14 Assessment and Training Matrix

Source: EBT Manual

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Adverse Weather	A	GND	Thunderstorm, heavy rain, turbulence, ice build up to include de-icing issues, as well as high temperature conditions. The proper use of use of anti-ice and de-icing systems should be included generally in appropriate scenarios.	Anticipate adverse weather Prepare for suspected adverse weather Recognize adverse weather Take appropriate action Apply appropriate procedure correctly Assure aircraft control	Predictive wind shear warning before take-off, as applicable	x	x				x		
			TO			Adverse weather scenario, e.g. thunderstorm activity, precipitation, icing		x			x	x		x
			TO			Wind shear encounter during take-off, not predictive	x			x			x	
			TO			Predictive wind shear warning during take-off	x	x				x	x	
			TO			Crosswinds with or without strong gusts on take-off	x			x				
			CRZ			Wind shear encounter scenario during cruise	x		x			x	x	x
			APP			Reactive wind shear warning during approach or go-around	x		x	x			x	
			APP			Predictive wind shear warning during approach or go-around	x	x				x	x	
			APP			Thunderstorm encounter during approach or on missed approach	x					x	x	
			APP			Increasing tailwind on final (not reported)	x	x				x	x	
			APP			Approach and landing in demanding weather conditions, e.g. turbulence, up and downdrafts, gusts and crosswinds including shifting wind directions				x		x	x	
			APP			Non-precision approach in cold temperature conditions, requiring altitude compensation for temperature, as applicable to type	x	x					x	
			APP LDG			Crosswinds with or without strong gusts on approach, final and landing (within and beyond limits)	x			x		x		
			APP			Reduced visibility even after acquiring the necessary visual reference during approach, due to rain or fog	x	x				x		

Generation 4 Jet — Recurrent Assessment and Training Matrix

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
							Competency map							
Evaluation and scenario-based training phases	Automation management	A	ALL	The purpose of this topic is to encourage and develop effective flight path management through proficient and appropriate use of flight management system(s), guidance and automation including transitions between modes, monitoring, mode awareness, vigilance and flexibility needed to change from one mode to another. Included in this topic is the means of mitigating errors described as: mishandled auto flight systems, inappropriate mode selection, flight management system(s) and autopilot usage.	Know how and when to use flight management system(s), guidance and automation Demonstrate correct methods for engagement and disengagement of auto flight system(s) Demonstrate appropriate use of flight guidance, auto thrust and other automation systems Maintain mode awareness of auto flight system(s), including engagement and automatic transitions Revert to different modes when appropriate Detect deviations from the desired aircraft state (flight path, speed, attitude, thrust, etc.) and take appropriate action. Anticipate mishandled auto flight system Recognize mishandled auto flight system. Take appropriate action if necessary Restore correct auto flight state Identify and manage consequences	ACAS warning, recovery and subsequent engagement of automation	x		x					
			ALL			FMS tactical programming issues, e.g. step climb, runway changes, late clearances, destination re-programming, executing diversion	x		x					
			ALL			Recoveries from TAWS, management of energy state to restore automated flight	x		x	x				
			ALL			Amendments to ATC cleared levels during altitude capture modes, to force mode awareness and intervention	x		x				x	
			TO			Late ATC clearance to an altitude below acceleration altitude	x		x				x	
			TO APP			Engine-out special terrain procedures	x		x				x	
			CRZ			Forcing AP disconnect followed by re-engagement, recovery from low or high speed events in cruise	x		x	x			x	
			CRZ			Engine failure in cruise to onset of descent using automation	x		x					
			CRZ			Emergency descent	x		x					
			DES APP			Managing high energy descent capturing descent path from above (correlation with unstable approach training)	x		x				x	
			APP			No ATC clearance received prior to commencement of approach or final descent	x		x				x	
			APP			Reactive wind shear and recovery from the consequent high energy state	x		x				x	
			APP			Non precision or infrequently flown approaches using the maximum available level of automation	x		x					
			APP			Gear malfunction during approach		x				x		x
			APP			ATC clearances to waypoints beyond programmed descent point for a coded final descent point during an approach utilising a final descent that is commanded by the flight management system.	x		x				x	

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Fire and smoke management	C	GRD	This includes engine, electric, pneumatic, cargo fire, smoke or fumes	Recognize fire, smoke or fumes Take appropriate action Apply appropriate procedure correctly Maintain aircraft control Manage consequences	Fire in cargo or cabin/cockpit at gate	x	x				x		x
			GRD			Fire during taxi	x	x				x		x
			GRD			Fire with no cockpit indication	x	x				x		x
			TO			Take-off low speed	x		x		x	x		
			TO			Take-off high speed below V1	x		x		x	x		
			TO			Take-off high speed above V1	x				x	x		
			TO			Initial climb	x				x	x		
			CRZ			Cargo fire						x	x	x
			APP			Engine fire in approach (extinguishable)		x				x		
			APP			Engine fire in approach (non-extinguishable)		x			x	x		
			APP			Flight deck or cabin fire		x			x	x		
	Loss of communications	C	GRD	Lost or difficult communications. Either through pilot mis-selection or a failure external to the aircraft. This could be for a few seconds or a total loss	Recognize loss of communications Take appropriate action Execute appropriate procedure as applicable Use alternative ways of communications Manage consequences	Loss of communications during ground manoeuvring	x	x						
			TO			Loss of communications after take-off	x					x		
			APP			Loss of communications during approach phase, including go-around	x	x				x	x	
	Managing loading, fuel, performance errors	C	ALL	A calculation error by one or more pilots, or someone involved with the process, or the process itself, e.g. incorrect information on the load sheet	Anticipate the potential for errors in load/fuel/performance data Recognize inconsistencies Manage/avoid distractions Make changes to paperwork/aircraft system(s) to eliminate error Identify and manage consequences	This can be a demonstrated error, in that the crew may be instructed to deliberately insert incorrect data, for example to take-off from an intersection with full length performance information. The crew will be asked to intervene when acceleration is sensed to be lower than normal, and this may be part of the operator procedures, especially when operating mixed fleets with considerable variations in MTOM	x	x						x

Generation 4 Jet — Recurrent Assessment and Training Matrix

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
							Competency map							
Evaluation and scenario-based training phases	Workload, distraction, pressure	B	ALL	This is not considered a topic for specific attention on its own, but more as a reminder to programme developers to ensure that pilots are exposed to immersive training scenarios which expose them to manageable high workload and distractions during the course of the EBT programme, at the defined frequency	Manage available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances	Intentionally blank	Intentionally blank							
	ATC	C	ALL	ATC error. Omission, miscommunication, garbled, poor quality transmission. All of these act as distractions to be managed by the crew. The scenarios should be combined where possible with others of the same or higher weighting, the principle reason being to create distractions.	Respond to communications appropriately Recognize, clarify and resolve any ambiguities. Refuse or question unsafe instructions. Use standard phraseology whenever possible	ATC role-play: the instructor provides scripted instructions, as a distraction to the crew	x	x			x			
						Controller error, provided by the instructor according to a defined scripted scenario	x	x				x	x	
						Frequency congestion, with multiple aircraft using the same frequency		x						
						Poor quality transmissions		x						
	Engine failure	C	TO	Any engine failure or malfunction, which causes loss or degradation of thrust that impacts performance. This is distinct from the engine-out manoeuvres described in the manoeuvres training section above, which are intended only for the practice of psychomotor skill and reinforcement of procedures in managing engine failures	Recognize engine failure Take appropriate action Apply appropriate procedure correctly Maintain aircraft control Manage consequences	Take-off low speed	x		x			x		x
			TO			Take-off high speed below V1	x		x			x		x
			TO			Take-off above V1	x					x	x	x
			TO			Initial climb	x					x	x	
			APP			Engine malfunction	x					x		x
			CRZ			Engine failure in cruise								
			LDG			On landing				x				

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Surprise	B	ALL	The data analysed during the development of this manual and of the EBT concept indicated substantial difficulties encountered by crews when faced with a threat or error, which was a surprise, or an unexpected event. The element of surprise should be distinguished from what is sometimes referred to as the "startle factor", the latter being a physiological reaction. Wherever possible, consideration should be given towards variations in the types of scenario, times of occurrences and types of occurrence, so that pilots do not become overly familiar with repetitions of the same scenarios. Variations should be the focus of EBT programme design, and not left to the discretion of individual instructors, in order to preserve programme integrity and fairness	Exposure to an unexpected event or sequence of events at the defined frequency	Intentionally blank	Intentionally blank							
	Terrain	B	ALL	Alert, warning, or conflict	Anticipate terrain threats Prepare for terrain threats Recognize unsafe terrain clearance Take appropriate action Apply appropriate procedure correctly Maintain aircraft control Restore safe flight path Manage consequences	ATC clearance giving insufficient terrain clearance	x	x			x			
			ALL			Demonstration of terrain avoidance warning systems						x	x	x
			TO CLB			Engine failure where performance is marginal leading to TAWS warning		x		x				x
			DES			"Virtual mountain" meaning the surprise element of an unexpected warning. Care should be exercised in creating a level of realism, so this can best be achieved by an unusual and unexpected change of route during the descent						x	x	x

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
			APP			On approach	x					x		x
			APP			Go-around	x					x		x
			LDG			During landing	x	x		x		x	x	
Evaluation and scenario-based training phases	Aircraft system management	B		Normal system operation according to defined instructions	This is not considered as a stand-alone topic. It links with the topic "compliance" Where a system is not managed according to normal or defined procedures, this is determined as a non-compliance	See "compliance" topic above. There are no defined scenarios, but the instructor should focus on learning opportunities when system management non-compliances manifest themselves during other scenarios. Underpinning knowledge of systems and their interactions should be developed and challenged, and not merely the application of normal procedures	Intentionally blank							
	Approach, visibility close to minimum	B	APP	Any situation where visibility becomes a threat	Recognize actual conditions Observe aircraft and/or procedural limitations Apply appropriate procedure if applicable Maintain directional control and safe flight path	Approach in poor visibility	x		x	x				x
			APP			Approach in poor visibility with deteriorations necessitating a decision to go-around	x		x	x				
			LDG			Landing in poor visibility				x		x	x	
	Landing	B	LDG	Pilots should have opportunities to practice landings in demanding situations at the defined frequency. Data indicates that landing problems have their roots in a variety of factors, including appropriate decision making, in addition to manual aircraft control skills if difficult environmental conditions exist. The purpose of this item is to ensure that pilots are exposed to this during the programme	Landing in demanding environmental conditions, with malfunctions as appropriate	This topic should be combined with the adverse weather topic, aircraft system malfunctions topic or any topic that can provide exposure to a landing in demanding conditions	Intentionally blank							
	Runway or taxiway condition	B	TO	Contamination or surface quality of the runway, taxiway, or tarmac including foreign objects	Recognize hazardous runway condition Observe limitations Take appropriate action Apply appropriate procedure correctly Assure aircraft control	Planned anticipated hazardous conditions with dispatch information provided to facilitate planning and execution of appropriate procedures						x		
			TO			Unanticipated hazardous conditions, e.g. unexpected heavy rain resulting in flooded runway surface		x			x	x		
			TO			Stop / go decision in hazardous conditions					x	x		x

Assessment and training topic		Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							Competency map							
Evaluation and scenario-based training phases	Aircraft system malfunctions, including operations under MEL	B	ALL	Any internal failure(s) apparent or not apparent to the crew Any item cleared by the MEL but having an impact upon flight operations. E.g. thrust reverser locked Malfunctions to be considered should have one or more of the following characteristics: Immediacy Complexity Degradation of aircraft control Loss of primary instrumentation Management of consequences	Recognize system malfunction Take appropriate action including correct stop/go decision Apply appropriate procedure correctly Maintain aircraft control Manage consequences Apply crew operating procedure where necessary. Respond appropriately to additional system abnormals associated with MEL dispatch Immediacy Complexity Degradation of aircraft control Loss of primary instrumentation Management of consequences	For full details see the Malfunction Clustering methodology and results. At least one malfunction with each characteristic should be included every year. Combining characteristics should not reduce the number of malfunctions below 4 for each crewmember every year according to the EBT module cycle. See Part I, 3.8.3. System malfunctions requiring immediate and urgent crew intervention or decision, e.g. fire, smoke, loss of pressurisation at high altitude, failures during take-off, brake failure during landing. Example: Fire System malfunctions requiring complex procedures, e.g. multiple hydraulic system failures, smoke and fumes procedures Example: Major dual system electrical or hydraulic failure System malfunctions resulting in significant degradation of flight controls in combination with abnormal handling characteristics, e.g. jammed flight controls, certain degradation of FBW control Examples: Jammed horizontal stabiliser; Flaps and/or slats locked Malfunctions resulting in degraded flight controls System failures that require monitoring and management of the flight path using degraded or alternative displays Unreliable primary flight path information, unreliable airspeed. Example: Flight with unreliable airspeed System failures that require extensive management of their consequences (independent of operation or environment) Example: Fuel leak	Intentionally blank							
			TO			MEL items with crew operating procedures applicable during take-off						x		
			TO			Response to an additional factor that is affected by MEL item (e.g. system failure, runway state)		x		x		x		
			GRD			Malfunction during pre-flight preparation and prior to departure	x					x	x	
			GRD			Malfunction after departure	x					x	x	
			GRD			Malfunctions requiring immediate attention (e.g. bleed fault during engine start, hydraulic failure during taxi)								
			TO			Take-off high speed below V1	x				x	x		
			TO			Take-off high speed above V1	x					x		
			TO			Initial climb	x					x		

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Adverse wind	B	TO	Adverse wind/crosswind. This includes tailwind but not ATC mis-reporting of the actual wind	Recognize adverse wind conditions Observe limitations Apply appropriate procedures Maintain directional control and safe flight path	Take-off with different crosswind/tailwind/gust conditions						x		x
			TO			Take-off with unreported tailwind		x			x			
			TO			Crosswinds with or without strong gusts on take-off	x			x				
			APP			Increasing tailwind on final (not reported)	x	x				x	x	
			APP			Approach and landing in demanding weather conditions, e.g. turbulence, up and downdrafts, gusts and crosswind including shifting wind directions				x		x	x	
			APP			Adverse wind scenario resulting in increasing tailwind below DA (not reported)		x		x		x		
			APP			Adverse wind scenario including strong gusts and/or crosswind out of limits below DA (not reported)		x		x		x		
			APP			Adverse wind scenario including strong gusts and/or crosswind out of limits below 15 m (50 ft) (not reported)		x		x		x		
			APP LDG			Crosswind with or without strong gusts on approach, final and landing (within and beyond limits)	x			x		x		

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Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Competencies non-technical (CRM)	A	APP	This encapsulates communication; leadership and teamwork; problem solving and decision making; situation awareness; workload management. Emphasis should be placed on the development of leadership, shown by EBT data sources to be a highly effective competency in mitigating risk and improving safety through pilot performance	Communication: Demonstrate effective use of language, responsiveness to feedback and that plans are stated and ambiguities resolved. Leadership and teamwork: Use appropriate authority to ensure focus on the task. Support others in completing tasks. Problem solving and decision making: Detect deviations from the desired state, evaluate problems, identify risk, consider alternatives and select the best course of action. Continuously review progress and adjust plans. Situation awareness: Have an awareness of the aircraft state in its environment; project and anticipate changes. Workload management: Prioritize, delegate and receive assistance to maximize focus on the task. Continuously monitor the flight progress	GPS failure prior to commencement of approach associated with position drift and a terrain alert					x	x	x	
			DES			Cabin crew report of water noise below the forward galley indicating a possible toilet pipe leak, with consequent avionics failures					x	x	x	
			CRZ			Smoke removal but combined with a diversion until landing completed.		x			x	x	x	x
			CRZ			ACAS warning immediately following a go-around, with a descent manoeuvre required.		x			x	x	x	x
	Compliance	A	ALL	Compliance failure. Consequences of not complying with operating instructions (e.g. SOP). This is not intended to list scenarios, but instructors should ensure that observed non-compliances are taken as learning opportunities throughout the programme. In all modules of the programme, the FSTD should as far as possible be treated like an aircraft, and non-compliances should not be accepted simply for expediency.	Recognize that a compliance failure has occurred Make a verbal announcement Take appropriate action if necessary Restore safe flight path if necessary Manage consequences	The following are examples of potential compliance failures, and not intended to be developed as scenarios as part of an EBT Module: 1. Requesting flap beyond limit speed 2. Flaps or slats in the wrong position for phase of flight or approach 3. Omitting an action as part of a procedure 4. Failing to initiate or complete a checklist 5. Using the wrong checklist for the situation	Intentionally blank							

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							Competency map							
			LDG			Adverse wind, visibility, type specific, special consideration for long bodied aircraft, landing in minimum visibility for visual reference, with crosswind	x	x		x			x	
			LDG			System malfunction, auto flight failure at DA during a low visibility approach requiring a go-around flown manually	x		x	x			x	
Evaluation and scenario-based training phases	**ISI** Monitoring, cross checking, error management, mismanaged aircraft state	A	ALL	Developed scripted role-play scenarios encompassing the need to monitor flight path excursions from the instructor pilot (PF), detect errors and make appropriate interventions, either verbally or by taking control as applicable. The scenarios should be realistic and relevant, and are for the purpose of demonstration and reinforcement of effective flight path monitoring. Demonstrated role-play should contain realistic and not gross errors, leading at times to a mismanaged aircraft state, which can also be combined with upset management training	Recognize mismanaged aircraft state. Take appropriate action if necessary Restore desired aircraft state Identify and manage consequences	In-seat instruction: Deviations from the flight path, in pitch attitude, speed, altitude, bank angle		x					x	
			ALL			In-seat instruction: Simple automation errors (e.g. incorrect mode selection, attempted engagement without the necessary conditions, entering wrong altitude or speed, failure to execute the desired mode) culminating in a need for direct intervention from the PM, and where necessary taking control.		x					x	
			APP			In-seat instruction: Unstable approach or speed/path/vertical rate not congruent with required state for given flight condition	x	x					x	x
			LDG			In-seat instruction: Demonstration exercise — recovery from bounced landing, adverse wind, strong gusts during landing phase, resulting in a bounce and necessitating recovery action from the PM	x			x			x	
	Unstable approach	A	DES APP	Reinforce stabilised approach philosophy and adherence to defined parameters. Encourage go-arounds when crews are outside these parameters. Develop and sustain competencies related to the management of high energy situations		ATC or terrain related environment creating a high energy descent with the need to capture the optimum profile to complete the approach in a stabilised configuration	x		x				x	
			DES APP			ATC or terrain related environment creating a high energy descent leading to unstable conditions and requiring a go-around	x		x				x	
			APP			Approach and landing in demanding weather conditions, e.g. turbulence, up and downdrafts, gusts and crosswinds including shifting wind directions				x		x	x	
			APP			Increasing tailwind on final (not reported)	x	x				x	x	
			APP LDG			Crosswinds with or without strong gusts on approach, final and landing (within and beyond limits)	x			x		x		

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Navigation	C	GRD	External NAV failure. Loss of GPS satellite, ANP exceeding RNP, loss of external NAV source(s)	Recognize a NAV degradation. Take appropriate action Execute appropriate procedure as applicable Use alternative NAV guidance Manage consequences	External failure or a combination of external failures degrading aircraft navigation performance	x		x			x	x	
			TO CLB APP LDG			External failure or a combination of external failures degrading aircraft navigation performance		x			x	x	x	
	Operations or type specific	C		Intentionally blank	Intentionally blank	Intentionally blank	Intentionally blank							
	Pilot incapacitation	C	TO	Consequences for the non-incapacitated pilot	Recognize incapacitation Take appropriate action including correct stop/go decision Apply appropriate procedure correctly Maintain aircraft control Manage consequences	During take-off	x	x			x	x		
			APP			During approach	x			x				x
	Traffic	C	CLB CRZ DES	Traffic conflict. ACAS RA or TA, or visual observation of conflict, which requires evasive manoeuvring	Anticipate potential loss of separation Recognize loss of separation Take appropriate action Apply appropriate procedure correctly Maintain aircraft control Manage consequences	ACAS warning requiring crew intervention		x				x	x	x

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Generation 4 Jet — Recurrent Assessment and Training Matrix							*Competency map*							
Evaluation and scenario-based training phases	Go-around management	A	APP	Any threat or error which can result in circumstances which require a decision to go-around, in addition to the execution of the go-around. Go-around scenarios should be fully developed to encourage effective leadership and teamwork, in addition to problem solving and decision making, plus execution using manual aircraft control or flight management system(s) and automation as applicable. Design should include the element of surprise and scenario-based go-arounds should not be predictable and anticipated. This topic is completely distinct from the go-around manoeuvre listed in the manoeuvres training section that is intended only to practice psychomotor skill and a simple application of the procedures		Adverse weather scenario leading to a reactive wind shear warning during approach	x	x					x	x
			APP			Adverse weather scenario leading to a predictive wind shear warning during approach or go-around	x	x					x	x
			APP			Adverse weather scenario, e.g. thunderstorm activity, heavy precipitation or icing forcing decision at or close to DA/MDA	x					x	x	x
			APP			DA with visual reference in heavy precipitation with doubt about runway surface braking capability	x					x	x	x
			APP			Adverse wind scenario resulting in increasing tailwind below DA (not reported)		x		x		x		
			APP			Adverse wind scenario including strong gusts and/or crosswind out of limits below DA (not reported)		x		x		x		
			APP			Adverse wind scenario including strong gusts and/or crosswind out of limits below 15 m (50 ft) (not reported)		x		x		x		
			APP			Lost or difficult communications resulting in no approach clearance prior to commencement of approach or final descent	x		x				x	
			APP			Birds: large flocks of birds below DA once visual reference has been established				x		x	x	
			APP			System malfunction, landing gear malfunction during the approach								

Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
Generation 4 Jet — Recurrent Assessment and Training Matrix						*Competency map*							
Evaluation and scenario-based training phases: Manual aircraft control	A	ALL	The competency description is "Maintains control of the aircraft in order to assure the successful outcome of a procedure or manoeuvre"	Desired competency outcome: Demonstrates manual aircraft control skills with smoothness and accuracy as appropriate to the situation Detects deviations through instrument scanning Maintains spare mental capacity during manual aircraft control Maintains the aircraft within the normal flight envelope Applies knowledge of the relationship between aircraft attitude, speed and thrust	Flight with unreliable airspeed, which may be recoverable or not recoverable	x			x			x	
		ALL			Alternate flight control modes according to malfunction characteristics	x			x				x
		ALL			ACAS RA to descend or ATC immediate descent	x	x		x				
		DES			TAWS warning when deviating from planned descent routing, requiring immediate response	x			x	x			
		TO			Scenario immediately after take-off which requires an immediate and overweight landing			x	x	x	x		
		TO			Adverse wind, crosswinds with or without strong gusts on take-off	x			x				
		TO			Adverse weather, wind shear, wind shear encounter during take-off, with or without reactive warnings	x			x			x	
		TO			Engine failure during initial climb, typically 30-60 m (100-200 .ft)	x	x		x				x
		CRZ			Wind shear encounter scenario during cruise, significant and rapid change in windspeed or down/updrafts, without wind shear warning	x		x			x	x	x
		APP			Adverse weather, wind shear, wind shear encounter with or without warning during approach	x		x	x			x	
		APP			Adverse weather, deterioration in visibility or cloud base, or adverse wind, requiring a go-around from visual circling approach, during the visual segment	x	x	x	x		x	x	x
		APP LDG			Adverse wind, crosswinds with or without strong gusts on approach, final and landing (within and beyond limits)	x			x		x		
		APP LDG			Adverse weather, adverse wind, approach and landing in demanding weather conditions, e.g. turbulence, up and downdrafts, gusts and crosswinds including shifting wind directions				x		x	x	
		APP LDG			Circling approach at night in minimum in-flight visibility to ensure ground reference, minimum environmental lighting and no glide slope guidance lights								
		APP LDG			Runway incursion during approach, which can be triggered by ATC at various altitudes or by visual contact during the landing phase	x			x			x	

Generation 4 Jet — Recurrent Assessment and Training Matrix

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
							Competency map							
Evaluation and scenario-based training phases	Upset recovery	C	ALL	An airplane upset is defined as an airplane in flight unintentionally exceeding the parameters normally experienced in line operations or training. 1. Pitch attitude greater than 25° nose up. 2. Pitch attitude greater than 10° nose down. 3. Bank angle greater than 45°. 4. Within pitch and bank angle normal parameters, but flying at airspeeds inappropriate for the conditions.	Recognize upset condition Take appropriate action Assure aircraft control Maintain or restore a safe flight path Assess consequential issues Manage outcomes	Upset recognition: Demonstration of the defined normal flight envelope and any associated changes in flight instruments, flight director systems, and protection systems. This should take the form of an instructor-led exercise to show the crew the points beyond which an upset condition could exist			x	x			x	x
			TO APP			Upset recognition and recovery — Severe wind shear or wake turbulence during take-off or approach			x	x		x	x	
			CLB DES			Upset recognition and recovery — as applicable and relevant to aircraft type, demonstration at a suitable intermediate level, with turbulence as appropriate; practice steep turns and note the relationship between bank angle, pitch and stalling speed				x			x	
			CRZ			Upset recognition and recovery — at the maximum cruise flight level for current aircraft weight, turbulence to trigger overspeed conditions (if FSTD capability exists, consider use of vertical wind component to add realism)			x	x		x	x	
			CRZ			Upset recognition and recovery — at the maximum cruise flight level for current aircraft weight, turbulence and significant temperature rise to trigger low speed conditions (if FSTD capability exists, consider use of vertical wind component to add realism)	x			x			x	
			CRZ			Upset recognition and recovery — demonstration at a normal cruising altitude, set conditions and disable aircraft systems as necessary to enable trainee to complete stall recovery according to OEM instructions	x			x			x	
			APP			Upset recognition and recovery — demonstration at an intermediate altitude during early stages of the approach, set conditions and disable aircraft systems as necessary to enable trainee to complete stall recovery according to OEM instructions	x			x			x	

	Assessment and training topic	Frequency	Flight phase for activation	Description (include type of topic, being threat, error or focus)	Desired outcome (includes performance criteria OR training outcome)	Example scenario elements	Application of procedures	Communication	Flight path management, automation	Flight path management, manual control	Leadership and teamwork	Problem solving and decision making	Situation awareness	Workload management
	Generation 4 Jet — Recurrent Assessment and Training Matrix						Competency map							
Evaluation and scenario-based training phases	**ISI** Upset recovery	C	CLB DES			Recovery: Demonstration, in-seat instruction: the instructor should position the aircraft within but close to the edge of the normal flight envelope before handing control to the trainee to demonstrate the restoration of normal flight. Careful consideration should be given to flying within the normal flight envelope				x			x	
	Wind shear recovery	C	TO	With or without warnings including predictive. A wind shear scenario is ideally combined into an adverse weather scenario containing other elements.	Anticipate potential for wind shear Avoid known wind shear or prepare for suspected wind shear Recognize wind shear encounter Take appropriate action Apply appropriate procedure correctly Assure aircraft control Recognize out of wind shear condition Maintain or restore a safe flight path Assess consequential issues and manage outcomes	Predictive wind shear warning during take-off					x	x		
			TO			Wind shear encounter during take-off	x				x	x		
			TO			Wind shear encounter after rotation						x		x
			TO			Predictive wind shear after rotation					x	x		
			APP			Predictive wind shear during approach	x				x	x		
			APP			Wind shear encounter during approach	x				x	x		

Annex B

CORE COMPETENCIES AND BEHAVIOURAL INDICATORS

Table 13 Core Competencies and Behavioural Indicators

Source: EBT Manual

Competency	**Competency description**	**Behavioural indicator**
Application of Procedures	Identifies and applies procedures in accordance with published operating instructions and applicable regulations, using the appropriate knowledge.	Identifies the source of operating instructions. Follows SOPs unless a higher degree of safety dictates an appropriate deviation Identifies and follows all operating instructions in a timely manner Correctly operates aircraft systems and associated equipment Complies with applicable regulations. Applies relevant procedural knowledge
Communication	Demonstrates effective oral, non-verbal and written communications, in normal and non-normal situations.	Ensures the recipient is ready and able to receive the information Selects appropriately what, when, how and with whom to communicate Conveys messages clearly, accurately and concisely Confirms that the recipient correctly understands important information Listens actively and demonstrates understanding when receiving information Asks relevant and effective questions Adheres to standard radiotelephone phraseology and procedures Accurately reads and interprets required company and flight documentation

		Accurately reads, interprets, constructs and responds to datalink messages in English Completes accurate reports as required by operating procedures Correctly interprets non-verbal communication Uses eye contact, body movement and gestures that are consistent with and support verbal messages
Aircraft Flight Path Management, automation	Controls the aircraft flight path through automation, including appropriate use of flight management system(s) and guidance.	Controls the aircraft using automation with accuracy and smoothness as appropriate to the situation Detects deviations from the desired aircraft trajectory and takes appropriate action Contains the aircraft within the normal flight envelope Manages the flight path to achieve optimum operational performance Maintains the desired flight path during flight using automation whilst managing other tasks and distractions Selects appropriate level and mode of automation in a timely manner considering phase of flight and workload Effectively monitors automation, including engagement and automatic mode transitions
Aircraft Flight Path Management, manual control	Controls the aircraft flight path through manual flight, including appropriate use of flight management system(s) and flight guidance systems.	Controls the aircraft manually with accuracy and smoothness as appropriate to the situation Detects deviations from the desired aircraft trajectory and takes appropriate action Contains the aircraft within the normal flight envelope Controls the aircraft safely using only the relationship between aircraft attitude, speed and thrust

		Manages the flight path to achieve optimum operational performance Maintains the desired flight path during manual flight whilst managing other tasks and distractions Selects appropriate level and mode of flight guidance systems in a timely manner considering phase of flight and workload Effectively monitors flight guidance systems including engagement and automatic mode transitions
Leadership and Teamwork	Demonstrates effective leadership and team working.	Understands and agrees with the crew's roles and objectives. Creates an atmosphere of open communication and encourages team participation Uses initiative and gives directions when required Admits mistakes and takes responsibility Anticipates and responds appropriately to other crew members' needs Carries out instructions when directed Communicates relevant concerns and intentions Gives and receives feedback constructively Confidently intervenes when important for safety Demonstrates empathy and shows respect and tolerance for other people[74] Engages others in planning and allocates activities fairly and appropriately according to abilities

[74] This behavioural indicator should only be used in the context of debriefing after an EBT session and not be recorded.

		Addresses and resolves conflicts and disagreements in a constructive manner Projects self-control in all situations
Problem Solving and Decision Making	Accurately identifies risks and resolves problems. Uses the appropriate decision-making processes.	Seeks accurate and adequate information from appropriate sources Identifies and verifies what and why things have gone wrong Employ(s) proper problem-solving strategies Perseveres in working through problems without reducing safety Uses appropriate and timely decision-making processes Sets priorities appropriately Identifies and considers options effectively. Monitors, reviews, and adapts decisions as required Identifies and manages risks effectively Improvises when faced with unforeseeable circumstances to achieve the safest outcome
Situation Awareness	Perceives and comprehends all of the relevant information available and anticipates what could happen that may affect the operation.	Identifies and assesses accurately the state of the aircraft and its systems Identifies and assesses accurately the aircraft's vertical and lateral position, and its anticipated flight path. Identifies and assesses accurately the general environment as it may affect the operation Keeps track of time and fuel Maintains awareness of the people involved in or affected by the operation and their capacity to perform as expected Anticipates accurately what could happen, plans and stays ahead of the situation

		Develops effective contingency plans based upon potential threats Identifies and manages threats to the safety of the aircraft and people. Recognizes and effectively responds to indications of reduced situation awareness.
Workload Management	Manages available resources efficiently to prioritize and perform tasks in a timely manner under all circumstances.	Maintains self-control in all situation Plans, prioritizes and schedules tasks effectively Manages time efficiently when carrying out tasks Offers and accepts assistance, delegates when necessary and asks for help early Reviews, monitors and cross-checks actions conscientiously Verifies that tasks are completed to the expected outcome Manages and recovers from interruptions, distractions, variations and failures effectively

Annex C

sabenaflight academy

BASIC INSTRUMENT FLYING TRAINING MODULE TRAINING RECORD	1-9
	01/11/2006
	v1.0

GRADES SESSION FS4		GRADE					MARKERS								
	EXERCISE	UNSATISFACTORY	SHOULD IMPROVE	STANDARD LOW	STANDARD	ABOVE STANDARD	AIRCRAFT HANDLING	COMMUNICATION	NAVIGATION	PROCEDURES	RESOURCE MANAGEMENT	SITUATIONAL AWARENESS	SYSTEM OPERATION	DECISION MAKING	MONITORING & CHALLENGING
1	TAKEOFF & CLIMB														
2	INTERCEPTION & TRACKING (NDB OR VOR)														
3	HOLDING (NDB OR VOR)														
4	APPROACH PREPARATION														
5	NON PRECISION APPROACH														
6	GO AROUND														
7	PRECISION APPROACH														
8	TAKEOFF – ENGINE FAILURE ON TAKEOFF														
9	EFP														
10	APPROACH PREPARATION														
11	ENGINE OUT PRECISION APPROACH														
12	GO AROUND														
	ITEMS AT DISCRETION OF INSTRUCTOR														
13															
14															
15															
	OVERALL GRADE FOR THE SESSION														
	BASIC INSTRUMENT FLYING SKILLS														

	NON-TECHNICAL SKILLS					
	PREPARATION FOR THE SESSION					
	COCKPIT DISCIPLINE					
	MULTI TASKING					
	SITUATIONAL AWARENESS					
	VERTICAL AWARENESS					
	LATERAL AWARENESS					
	WORKLOAD & STRESS MANAGEMENT					
	TIME MANAGEMENT					
	LEARNING CURVE					

GRADE PF & PM   GRADE PF ONLY   GRADE PM ONLY

INDICATE MARKER(S) WHEN AN EXERCISE IS GRADED 'UNSATISFACTORY', 'SHOULD IMPROVE' OR 'ABOVE STANDARD'

WHEN AN EXERCISE IS NOT PERFORMED, INDICATE IN THE COLUMN 'STANDARD': 'T' (DUE TIME), 'F' (DUE SIMULATOR FAILURE) OR 'P' (SINCE TRAINEE ALREADY PROFICIENT)

 BIF TRAINING MODULE

Figure 15 Training Module Evaluation Sheet

Source: Sabena Flight Academy

Name		Date	

BIF TRAINING MODULE EVALUATION SHEET

US=Unstaisfactory – **SI**=Should improve – **SL**=Standard low – **S**=Standard – **AS**=Above standard

		US	SI	SL	S	AS	COMMENTS (Continue on next page If required)
FLIGHT	Basic instrument flying General assessment						
	Attitude control						
	Altitude control						
	Speed & thrust control						
	Heading control						
	Accuracy of aircraft handling						
	Navigation skills						
	Situational awareness						
	Multi tasking						
	Planning & anticipation						
	Learning curve						
	Knowledge of English						
	ATC communications						

		weak ------- strong <<<< --- >>>>					
	General behavior						
	Airmanship						

GENERAL ASSESSMENT	US	SI	SL	S	AS	❒ PASS	❒ FAIL (*)

Instructor's Signature:	Student's Signature :	Head of type rating training Signature :

(*) In case of a failed evaluation, specify the reason(s) and proposal for extra training (if applicable) on the next page.

COMMENTS (continued from previous page)	
Basic instrument flying General assessment	
Attitude control	
Altitude control	
Speed & thrust control	
Heading control	
Accuracy of aircraft handling	
Navigation skills	
Situational awareness	
Multi tasking	
Planning & anticipation	
Learning curve	
Other comments	
Airmanship	

Reasons for failure Proposal Extra Training (if applicable)	

Annex D

3.3.5 Instructor guide S3

1. Introduction

- Invite the client to place questions about anything covered up to this session
- Review lesson objectives
- Review session proficiency criteria
- Check client's performance calculation for the session

V1	VR	V2	THR	FLAPS

2. Briefing topics

- GPWS and EGPWS

  Recovery technique
  Explain the differences between GPWS and EGPWS
  Review the associated memory items
- Reactive and predictive windshear system

  Recovery technique:
  Explain the differences between reactive and predictive
  Review the associated memory items
- Non-precision approaches

  NPA managed
  NPA selected
  RNAV approach
  Explain the difference between managed and selected
  Explain the differences between early stabilized and decelerated approaches
  Explain how to insert the Vapp on the FAF and the reason for that
  Explain the different types of strategies
  Explain, according FCOM, what ND must be selected for the intended approach
- Circling approaches

  Explain the profile and the technique to be used
- G/S interception from above

  Explain the profile and the technique to be used

Figure 16 Instructor's Guide

Source: CAE

3. Lesson plan

CAE	A320 TYPE RATING COURSE Lesson Plan	S3 Rev. 03 Date: 01 MAY 2015	Phase 1 PHASE CHECK

Airport: EDDF	Environment: Day time	Session Length: 02:00

No	AP	AT	FG	EVENTS	LST
1				Cockpit inspection, Preflight Procedures, Transit Cockpit Preparation	1.3
2				Cockpit inspection, Before Start Procedures	1.3
3				Taxiing, Before taxi procedures	
4				Before take-off checks	
5				Taxiing	
6		Y	+	Normal take-offs, different flap setting incl. expedited take-off, Climb FL 70 on SID	
7				Autopilot/Flight director, AUTO FLT AP OFF, For the 2nd Student: A/THR FAILURE	3.4.8
8		Y	+	ACAS event	
9	Y	Y	+	Emergency procedures, EGPWS / CFIT	3.6.8
10	Y	Y	+	ILS with autopilot, G/S Interception from above	
11		Y	+	Normal landings also after an ILS approach with transition to visual flight on reaching DH, Crosswind, Rwy contaminated	
12		Y	-O-	Crosswind take-off	
13		Y	-O-	Windshear	
14		Y	+	Adherence to departure and arrival route and ATC instruction, Follow ATC instructions	
15		Y	-O-	GPS approach, For the 2nd Student: LOC Approach	
16				Missed approach procedures, After a non-precision-approach down to MDH/A, Radar Vectoring	4.2
17		Y	-O-	Non-precision-approach down to MDH/A, Full procedure VOR / DME approach	
18			+	Crosswind landings	5.3
19				Landing, After landing and taxi-in procedures, 180° on RWY	
20					

CTS Ref Nr	EVENTS	COMMENTS	0	1	2	3	4	5
FLIGHT PREPARATION								
1	Performance Calculation							
2	Cockpit Inspection and Before Take-Off Checks							
TAKE-OFF / DEPARTURE								
3	Normal Take-Offs							
4	Take-Off with Simulated Engine Failure							
5	Rejected Take-Off							
6	Adherence to Departure and Arrival Routes and ATC Instruction							
EVENTS								
7	Aircraft Systems, Normal Procedures							
8	Aircraft Systems, Abnormal Procedures							
9	Emergency Procedures							
FLIGHT								
10	Holding Procedures							
APPROACH								
11	Precision Approach, Manually without Flight Director							
12	Precision Approach, Manually with Flight Director							
13	Precision Approach with Autopilot							
14	Non-Precision Approach							
15	Circling							
16	Precision Approach, Man., w. Flight Director and One Eng. Inop.							
17	Precision Approach with Autopilot and One Engine Inoperative							
MISSED APPROACH								
18	Go-Around with All Engines Operating							
19	Go-Around with One Engine Inoperative							
LANDING								
20	Normal Landings							
21	Landings with Malfunctions Affecting Flight Controls							
22	Landing with One Engine Inoperative							
GENERAL THROUGHOUT THE WHOLE SESSION								
23	Use of Normal Checklist							
24	Use of Malfunction and Emergency Checklist / QRH							
25	Basic Flying Skills							
26	System Knowledge							
27	Procedure Knowledge							
28	CRM							
29	Pilot Non-Flying / Pilot Monitoring Performance							
30	Communication							

	OVERALL GRADE							
			0	1	2	3	4	5

No	Events
1	For 2nd Client: ENGINES RUNNING Reposition in the Init hold point with running engines. Insert the appropriate F/PLN. Ready for take-off.
6	TAKE-OFF Insert RWY contamination: COMPACTED SNOW. New performance calculation.
7	AP FAILURE Insert AP 1 failure during climb. Clients should engage AP2. When done, ask client 1 to disconnect AP2, not to follow FDs and to maintain 4° pitch. Show REVERSION. For 2nd client: AP FAILURE Clients should switch to the other AP in order to use the remaining A/THR channel.
8	TCAS Insert RA.
9	EGPWS Descent to 2.500 ft QNH heading for FFM Radial330 12 NM and wait until EGPWS activation.
13	WINDSHEAR Insert a windshear after liftoff to train the recovery technique.
15	GPS APPROACH RWY 25C
18	CROSS WIND LANDING Insert a 10kts crosswind according client performance.