Nationaal Lucht- en Ruimtevaartlaboratorium

National Aerospace Laboratory NLR

Executive summary

Qualification of military flight simulators

A proposed novel, Dutch approach for the qualification of military flight simulators

Introduction

The Military Aviation Authority of the Netherlands is developing a system for the qualification of military flight simulators. The aim is to give the operator maximum flexibility in the employment of existing and future simulators. There were no military rules for simulators or for its use. Simulators that replace military flight training need to have standards applicable to the typical military tasks. Initially it was investigated if the JAR or FAR could set these standards. However, it was quickly discovered that a new approach was needed.

Description of work

The proposed methodology for the qualification of military flight simulators is based on the following principles:

- Do not rate the complete simulator but qualify subsystems;
- Relate qualification levels to human perception and control behaviour;
- Rate the training tasks vs. subsystem qualification level.

The designed system rates all the major subsystems (sixteen in total). The number of levels per subsystem ranges between two and five. The highest level is determined by human sensory limitations. The 16 subsystems give a finer resolution to range each simulator. Also, each task requires a different subsystem performance. For example, an instrument approach differs

Report no.
NLR-TP-2009-249

Author(s)
H.J. Koolstra
C.J. Jansen

Report classification
UNCLASSIFIED

Date
May 2009

Knowledge area(s)
Aeronautical Human Factors
Training & Flight Simulation

Descriptor(s)
Flight simulation
Qualification of simulators
Military aircrew training
Helicopter training

This report is based on a presentation held at the RTO MSG-060 Symposium on "How is Modelling & Simulation Meeting the Defense Challenges Out to 2015?", Vancouver, Canada, 7-8 October 2008.

considerably from a landing in confined areas.

Results and conclusions

With our present effort we have set the first steps to regulate military simulator training, in a similar but still different way as in civil aviation. The military training is complex, expensive, but also extremely important. With our refined rating system, and our task oriented approach we give the operator the opportunity to get the maximum benefit out of his existing training assets and exploit all capabilities.

Furthermore, the operator can easily establish which simulator upgrades will allow extra training. This enables a cost effective approach for simulator upgrades. It enables him to weigh upgrades of the simulator against the reduction in required flight hours.

Nationaal Lucht- en Ruimtevaartlaboratorium, National Aerospace Laboratory NLR

Anthony Fokkerweg 2, 1059 CM Amsterdam,
P.O. Box 90502, 1006 BM Amsterdam, The Netherlands
Telephone +31 20 511 31 13, Fax +31 20 511 32 10, Web site: www.nlr.nl

Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

NLR-TP-2009-249

Qualification of military flight simulators

A proposed novel, Dutch approach for the qualification of military flight simulators

H.J. Koolstra[1] and C.J. Jansen

[1] MLA

This report is based on a presentation held at the RTO MSG-060 Symposium on "How is Modelling & Simulation Meeting the Defense Challenges Out to 2015?", Vancouver, Canada, 7-8 October 2008. Updates, based on the draft issue of MAR-FSTD H, December 2008, are included. The work is performed under contract for the Military Aviation Authority, the Netherlands.

The contents of this report may be cited on condition that full credit is given to NLR and the authors.

This publication has been refereed by the Advisory Committee AIR TRANSPORT.

Customer	Military Aviation Authority of the Netherlands
Contract number	----
Owner	NLR
Division NLR	Air Transport
Distribution	Unlimited
Classification of title	Unclassified
	October 2009

Approved by:

Author	Reviewer	Managing department
14-10-2009	05-11-2009	06-11-2009

Summary

The Military Aviation Authority of the Netherlands is developing a system for the qualification of military flight simulators. The aim is to give the operator maximum flexibility in the employment of existing and future simulators.

The following principles were used:
- Do not rate the complete simulator but qualify subsystems.
- Rate the training tasks vs. subsystem qualification level.

The designed system rates all the major subsystems (sixteen in total). The number of levels per subsystem ranges between two and five. The highest level is determined by human sensory limitations. The 16 subsystems give a finer resolution to range each simulator. Also, each task requires a different subsystem performance. For example, an instrument approach differs considerably from a landing in confined areas.

This system gives the operator the possibility to exploit all the capabilities. Furthermore, the operator can easyly establish which simulator upgrades will allow extra training. This enables a cost effective approach for simulator upgrades.

Contents

Abbreviations

ATC	Air Traffic Control
cd/m^2	$candela/metre^2$
ECM	Electronic Counter Measures
FSTD	Flight Simulation Training Device
H	Horizontal
IIR	Imaged InfraRed
JAR	Joint Aviation Requirement
FAR	Federal Aviation Requirement
FOV	Field of view
LOD	Level of detail
NVG	Night Vision Goggle
SVS	Synthetic Vision System
V	Vertical

1 Introduction

A Military Aviation Authority (MAA) is established in the Netherlands since 2005. The reason for the foundation of the MAA was to enhance flight safety by separating policy and oversight from execution in a similar way as in civil aviation. The MAA sets standards for maintenance, operation and training. Initial MAA publications were based on JAR and FAR but with adaptations to the typical military situation.

There were no military quality requirements for simulators, operators bought what they could afford and used it as thought to be the most practical way. Presently the high ops tempo and the lack of resources have emphasized the need for simulator training to replace the (not available) flying hours. And as missions are getting more complicated simulators are better suited for training. However, simulators that replace flying training need to posses certain standards and oversight to guarantee that the required quality criteria are met. Initially it was investigated if the JAR or FAR could set these standards. However, it was quickly discovered that a new approach was necessary.

The present development and this paper focus on helicopter training; it will be followed by qualification standards for fixed-wing aircraft next year.

[There are different simulators and flight training devices, in this paper we will use the term Flight Simulation Training Device (FSTD) which encompasses every form of synthetic flight training.]

2 JAR & FAR system versus military requirements

The JAA (and FAA via a comparable system) sets currency standards in the JAR-OPS and training standards in the JAR-FCL. The FSTD standards were set in the JAR-STD 2A for Flight Training Devices (without motion) and in the JAR-STD 1A for full flight simulators. The civil system distinguishes three different types of Flight Training Devices and four different types of full flight simulators. Since 1 August 2008 the JAR-FSTD H is effective, a more harmonized regulation which encompasses requirements for FTD and full flight simulators.

It is evident that all these civil regulations contain important and also useful information for a military organization. But there are also severe limitations. The first limitation is that civil regulations do not address typical military tasks and roles. A short summary of the most important differences:

- Responsive aircraft
- High gain control tasks
- Aggressive manoeuvring
- Very low level contour flying
- Obscured landing spots
- Deck landings
- Crowded (multi player environment)
- Military systems (IIR, NVG, Targeting pod, weapons, fire control radar, ECM equipment.)

A second difference is that the military does not have a variety of licenses but a wide variety of tasks. Operational use and continuation training is necessary for these tasks to keep all (required) qualifications up to date (active).

Therefore it is inappropriate to link an FSTD to a military license.

Figure 1: Helicopter performing a deck landing

But there is more. Traditionally simulation in the military was often not well funded[1)] . The operator's interest was to buy airframes and much less simulators. The basic idea was of course that a war was fought with airplanes and not with simulators. However, this approach was more

[1)]Ian Strachan: Cueing paper 1 July 2006: The author assesses the military employment of flight simulation technology as variable and in some cases, poor. It is certainly not as well organized and regulated as the civil scene. It is often starved of project resources, particularly if there is one of the inevitable crises in overall finance of the aircraft project when simulator numbers or quality may be cut " suited for the Cold War than for the present situation. In those days the systems were used for deterrence and not for actual combat; the consequence is that (in theory) all flying hours are training hours. But in the present situation with many aircraft engaged in actual operation, training hours are scarce. Furthermore, there are many training events which can not be trained adequately and safely during actual flying. Emergency handling is of course one type of events for which the simulator is well suited, but other typical military application as realistic threat representation and multi-ship operations (Composite Air Operation or COMAO) which consume a lot of resources fall in the same category.

Presently the military operator wants to use its FSTD as much as possible:

1. improved training possibilities;
2. to alleviate the burden on the aircraft.

To do that wisely and safely we have to qualify the military simulators, and not for a license but for a task.

3 The objective of our study

The objective of our study is to maximize the training value for the operator within certain safety boundaries. I.e. for which tasks to be trained can the simulator replace flying hours for which percentage. In other words, given a specific FSTD, with its inherent limitations, (for instance no motion), we seek to establish the maximum training which can be done in that FSTD!

3.1 The problem

To reach the objective two fundamental problems must be investigated.

1. What is the level of simulation required for a task to train that particular task completely in an FSTD?
2. What is the minimum acceptable level (no negative training) and how much training can be done on that particular simulator.

3.2 The chosen solution: the Dutch approach

From the start it became clear that a rigid system with for instance seven different kinds of simulators was not adequate to address the wide variety of military tasks to be trained. The use of such a system would jeopardize the initial objective, maximizing the training value for existing FSTDs. But on the other hand, we would also try to benefit from existing civil regulations for FSTDs. The solution found was by rating each of the different subsystems of an

FSTD separately while using existing JAA regulations to the maximum extend possible. The consequence is that for each task a decision must be made, which subsystem level gives adequate performance.

We are presently distinguishing seven hardware and eight software subsystems, most subsystems have three different fidelity levels, this provides us (in theory) with 3^{15} or over a million different ratings. So flexibility is assured.
Subsystems:

- Hardware :
  - Instructor Operator Station (IOS), Visual system (+field-of-view(FOV)), Motion system (+phase), Sound system, Cockpit
- Software
  - Performance & Control, helicopter subsystems, Avionics, Military sensors, Weather, ATC, Threats & Targets, Cooperative models, Integration.

An example of levels is given for the visual system

Table 1: Qualification levels for the Synthetic Vision System (SVS)
Level of detail, luminance

Qualification Level	General Technical Requirements
1	This system is a basic SVS with limited LOD, limited special effects. Luminance >17 cd/m², resolution < 6 arc minutes and FOV per pilot minimum 40ºH x 30ºV. The delay, in addition to the value experienced on the helicopter, shall not be greater than 150 msec.
2	High LOD incorporating many special effects (cloud break, weather, shadow etc.). The luminance >20 cd/m², resolution < 2 arc min and at least 10 occulting levels minimum 5000 polygons and tbd levels of texturing and an additional time delay of less than 100 msec.
3	This level accounts for future developments. The system should be a colour system with a luminance of > 300 cd/m², a resolution of around one arc minute around the foveal axis, contrast ratio > 100, 10000 polygons and 10 occulting levels. FOV identical to FOV from the actual pilot station. The additional delay shall be less than 100 msec. and the system shall incorporate all special effects for weather, cloud break, targets, shadow, target movement.
+ 0.2	Generic NVG capable (low light level and NVG compatible lighting)
+ 0.5	Accurate NVG representation (adapted database)

Visual field-of-view (FOV)

Qualification Level	General Technical Requirements		
1	FOV 45ºH x 30ºV	per pilot	(=JAR level A)
2	FOV 150ºH x 40ºV	per crew, continuous	(=JAR level C)
3	FOV 150ºH x 60ºV	per crew, continuous	
4	FOV 180ºH x 60ºV	per crew, continuous	(=JAR level D)
5	FOV identical with FOV from the pilot station of the simulated aircraft.		

4 Sources experimental evidence

What is required for 100% training value for military flight training?

To tackle the first problems, we investigated which scientific evidence was available. It was also clear that we should not start with the technicalities of simulation but start with human perception and control behaviour[2)] . If a certain subsystem could deliver a performance with equal or more precision than a human can perceive, the simulation is in principle good and further enhancements do not contribute to better training. So the highest level of a subsystem can even be set in absolute terms independent of the state of technology.

4.1 Control forces and dynamics

Let us give a few examples here: If we take the feel system of the stick and rudder we know that the human is very sensitive to small deviations in break out forces and time delays but far less sensitive to rate the applied force per g. A ten percent difference in stick forces per g will not be noticed by the pilot. This means that this 10 percent is adequate as an absolute accuracy level for stick forces per g. (This 10 percent allowance in control forces is a requirement which can be found in the JAA as well, however, without justification). A similar conclusion can be made concerning aircraft dynamic motions. These motions are normally characterized by their frequency and damping and represented by a set of second order differential equations. The accuracies asked by the JAA for damping and frequency are quite high. Our experience is that during actual flight test differences between similar test points are sometimes higher than the precision required by JAA! A typical example is spiral stability, a small disturbance or hardly noticeable trim difference can change the measured time constant considerably and sometimes even reverse the direction, (even a sign change!). So the control system requirements of the JAA for the highest level of simulators are adequate as absolute levels and also good enough for

[2)] As source for human performance we used the Engineering Data Compendium, Human Perception and Performance by Kenneth R. Boff e.a. 1988.

every task. But there might also be tasks which can be done with a more limited system. (for example a task which is mainly done while flying on autopilot). So generally, the JAR requirements for control forces and dynamic response are well within human perception limits and adequate for all military use as well. However, the military flight envelope might be larger. Furthermore, specific attention must be given to the integration, especially time delays and phase differences during high gain tasks can be detrimental.

4.2 The vision system

A more complicated example is the human vision. It is clear that in real life contrast and light levels are many orders of magnitude larger than can be obtained with synthetic vision systems. For example, the maximum brightness in real life can be as large as 100,000 cd/m2. But that does not automatically imply that 100.000 cd/m2 is required for the highest level vision system. Human perception studies have detected a direct relation between resolution and light level. Evidence shows that at 300 cd/m2 the human eye has already reached its maximum accuracy (one arc minute). This implies that a higher luminance level than 300 cd/m2 is not required, at least not to maximize its resolution. Of course this is not the only resolution requirement; the database (polygons and texturing) should support that same resolution. A further refinement can be made for head steered system, only close to the foveal axis a high resolution is required. Many new systems exploit this feature already, but this is presently not addressed in civil simulators. Based on this evidence it is possible to establish the maximum level for visual systems independent of the present state of technology.

An interesting deviation from the civil regulations is required for the Field of View.(FOV). Military operations require quite often extended FOVs, way beyond the maximum used in civil aviation. Furthermore, in civil regulations the requirements for detail and FOV are linked. For the military classification it was more appropriate to separate FOV from the resolution and brightness and to use it as an independent performance indicator.

4.3 Motion s(t)imulation

As the motion envelope of any motions system (moving platform) is much smaller than the real aircraft motions it will always be necessary to filter the motion signals from the simulated air vehicle. In addition a solution to simulate the effect of sustained Z-acceleration the pilot’s G-suit can be pressurized at a reduced pressure level.

An example:
Even with a motion platform with a relatively small displacement (total 0.6 m in heave) it was possible to realistically simulate a high performance fighter.

As the simulator was used during the development of the flight control system motion cues were necessary to encompass the effect of motion on the manual control of the aircraft.

By dividing the flight envelope in smaller segments, e.g. aerial target, ground attack, and landing, it was possible to adjust motion system and motion filtering settings to the tasks being evaluated. Emphasis was placed on small phase difference which was traded in for low gain.

After the first real flights the chief test pilot remarked: “The aircraft flies the same as the simulator”. So even with a small motion platform it was possible to simulate handling and control characteristics correctly.

Another example comes from a simulation of handling qualities of another fly-by-wire fighter during landings in wind and turbulence conditions. In this case a system with a slightly larger than standard heave capability (total 2.1 m instead of 1.7 m) was used

During the simulator tests the operator noticed that the aircraft could not be handled in these conditions, which contradicted earlier assessments in a static simulation with a small out-the-window view, but was in agreement with actual flight results.

Comparing stick activity (manoeuvre input removed) versus wind/turbulence level showed that a moving base simulation with a wide field-of-view was necessary to get the same pilot reactions as in real flight.

Based on these simulator trials the flight control system was successfully modified.

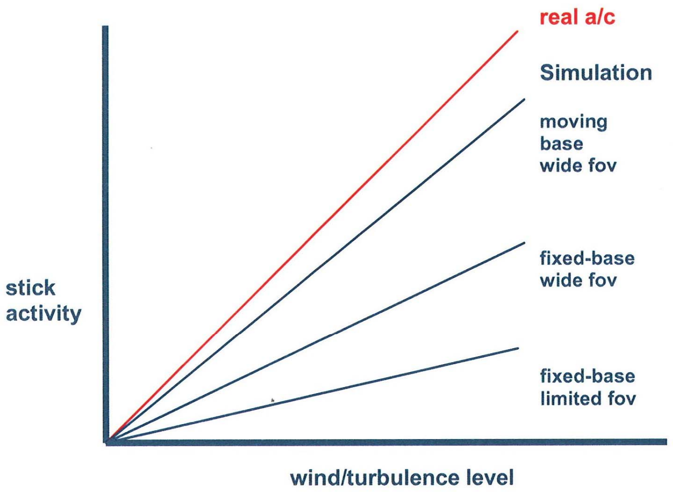

Figure 2: Stick activity vs wind/turbulence level for various training media

The main contribution of motion to reality is that it stabilizes the control during high gain tasks. High gain task are high frequent, therefore the initial reaction is the most important contribution. Sustained high loads, do not influence control, but are of course demanding for the operator. So only the physical stress is less but there is limited risk for negative transfer of training. Our conclusion is that the overall envelope of present civil D level motion system[3)] is adequate for all high gain tasks, the simulation of turbulence and vibrations.

4.4 Integration

For the high-gain military tasks it is vital that not only the response of each subsystem is within the required time frames, but also any additional time delays between e.g. controls, visual, motion shall be within strict limits.

4.5 Cockpit

For 100% fidelity the cockpit should be identical to the real air vehicle. As controls, instruments etc. are available for the real helicopter this is no issue. Depending on the tasks to be trained and budget constraints, part of the instruments can be replaced by flat panels.

4.6 Sound

High quality sound systems are technically capable of producing any sound within and even above human hearing capacity. The real problem is of course not the sound itself but the underlying models and how the interaction with other participants is realized.
To start with the last item, tests have shown that in a multi player environment, with many participants communicating in many groups, this is a feasible, but challenging task. But even in a ´simple´ instrument flying situation there are more players than the ATC controller. Because many aircraft incidents and accidents have communication errors as a main cause or at least as a contributing factor, the realistic simulation of ATC and other players have received more attention in the civil world as well. So accurate sound requires a good engine and airframe sound model and interaction with avionics, ATC, threats and targets and cooperative player models including Command and Control (C-2).

5 Task qualification

The second part of the same problem is to set the requirements per task. Not every task will exploit each sub system to the limit. An obvious example is flight under instrument conditions which gives quite a relaxed requirement for the visual system. However, when cloud break and instrument landing are required the level of detail and FOV required increases. A checklist was developed to rate each task against the subsystems. This was used by subject matter experts to rate each task. The checklist is included below.

[3)] The military requirements are more stringent than civil level –D for phase.

Table 2 Subsystems level required for the task

Subsystems level required for the task

1. Visual
   a. Can the task be performed with minimal visual inputs? E.g. no special effects, low level of detail, night & dusk only display in a restricted FOV – If yes level 1
   b. Is high level detail required? If yes level 2:
   c. Is target tracking required? If yes level 3
   d. Are operation carried out close to the ground or in confined areas?: If yes level 3
   e. Which FOV is required?: 1, 2, 3, 4, 5
2. Motion & feel:
   a. Is the task high gain or are motion inputs primary triggers: Minimum level 1
   b. Is the movement also multi axis: minimum level 2.
   c. Does the task require aircraft vibration cues: minimum level is 3.
   d. If level 2 or 3 motion is required phase difference should be less than 60 degrees during typical task execution. Phase difference of less than 30 degrees is required for 100% flight replacement.
3. Sound:
   a. Are engine sounds required for this task: level 1.
   b. Are sounds of on board avionic system required: level 2.
   c. Is generic ATC required: Level 3
   d. Is the simulation of realistic air traffic and team members required: level 4.
4. Cockpit:
   a. Is a basic cockpit with generic controls and instruments sufficient?: level 1
   b. Is a representative cockpit with controls and instruments necessary for the training task required?: level 2
   c. Is an exact replica of the cockpit required?: level 3
5. Performance and flying qualities
   a. Does the task only require generic aircraft performance and handling? If yes minimum level 1
   b. Does the simulation require aircraft <u>type specific</u> (=representative?) handling and performance simulation? If yes minimum level 2
   c. Does the simulation require <u>aircraft specific</u> handling and performance? If yes minimum level 3.
   d. Is low speed handing, ground handling or ground effect required? If yes level 4.
6. Aircraft systems (Electric, hydraulic pneumatic, engine, anti icing, oxygen)
   a. Does the task only require a single system operation: level 1
   b. Is normal system operation required for this task: level 2
   c. Is normal and abnormal system operation required: level + 0.5
7. Aircraft avionic (Communication, navigation, identification, CAS, GCAS , Auto pilot and FMS)
   a. Does the task only require a single system operation: level 1
   b. Does the task require all system to operation normally: level 2
   c. Is normal and abnormal system operation required and does the data base need to be updatable: level + 0.5
8. Military sensors
   a. If only generic sensor performance with correct switchology is required the minimum is level 1.
   b. If specific sensor performance is required the minimum is level 2.
   c. If sensor *integration with other databases* is required the minimum is level +0.2.
   d. If normal and abnormal system operation is required and if the data bases need to be updatable the minimum is level +0.5.
9. Weather model
   a. Is realistic and controllable ceiling, wind and temperature and pressure required: Level 1
   b. Are weather effects like snow rain, hail required: level 2
   c. Is turbulence , wind shear and icing simulation required: level 3
   d. Are runway conditions required: level + 0.5
10. ATC Model
    a. Are navigation beacons, approach aids and airfield required: level 1
    b. Is ATC chatter and communications needed: level 2
    c. Is correlated ATC Chatter and Communication needed: level 3. (correlated with visual and radar)
    d. Is a dynamic ATC and automated environment needed: level 4
11. Cooperative systems and targets.
    a. All target and cooperative models should be listed. The level is determined per model.
    b. Generic/representative models (for initial training): level 1
    c. Specific models, exactly corresponding to the training theatre with a realistic target: level 2.
12. All systems (Integration)
    a. No high gain tasks and low level of detail visual: level 1, time delay < 150 msec).
    b. High gain tasks high level of detail visual: level 2. (time delay <100 msec).
    c. High gain task, high detail cooperative models and high level of visual detail: Level 3 (time delay<50 msec).
    d. Simulator is integrated in a network, +0.5 Integration delay with team mates should be <100 msec.

Note: + 0.5 & 0.2 mean “in addition above the level itself”

6 What is the minimum fidelity required?

The more difficult part came next, what is the minimum level for a simulator subsystem to support some training in a specific task. There is limited scientific evidence on how little is enough. The civil authorities do allow using an FTD for initial instrument training for 40% of the required training hours. And this 40% is widely used but it is hard to find any scientific evidence which validate this number, but we know from experience that a large portion of the initial instrument training can be done adequately in a limited performance FSTD. Another source is the Rasmussen[4] taxonomy.

> *The Skills, Rules, Knowledge (SRK) framework or SRK taxonomy defines three types of behaviour or psychological processes present in operator information processing. The SRK framework was developed by Rasmussen (1983) to help designers combine information requirements for a system and aspects of human cognition. #4*

We know that for using a skill a high level of realism is required and less for the training of procedures. For the knowledge based training a simulator might not be necessary at all, instead graphs showing system operation might be more suitable. On the other hand, a pilot confronted with knowledge based problems should solve that while maintaining aircraft control, which compound to the task difficulty.

One source of information discovered was the 'Master' experiments carried out between 1998 and 1999[5)]. These experiments investigated amount of errors in aerobatic training between three groups. The control group did not have any simulator training, the X-1 group had a simple PC based system with a COTS control system and the X-2 group was also PC based but with realistic control and feel system. This experiment underlines that even this limited system was capable to provide training which was clear from the reduction in errors.

---

[4]) #4 Rasmussen, J. (1983). Skills, rules, knowledge; signals, signs, and symbols, and other distinctions in human performance models. IEEE Transactions on Systems, Man and Cybernetics, 13, 257-266.

[5)]Handbook of Simulator Based Training , Eric Farmer e.a. 1999.

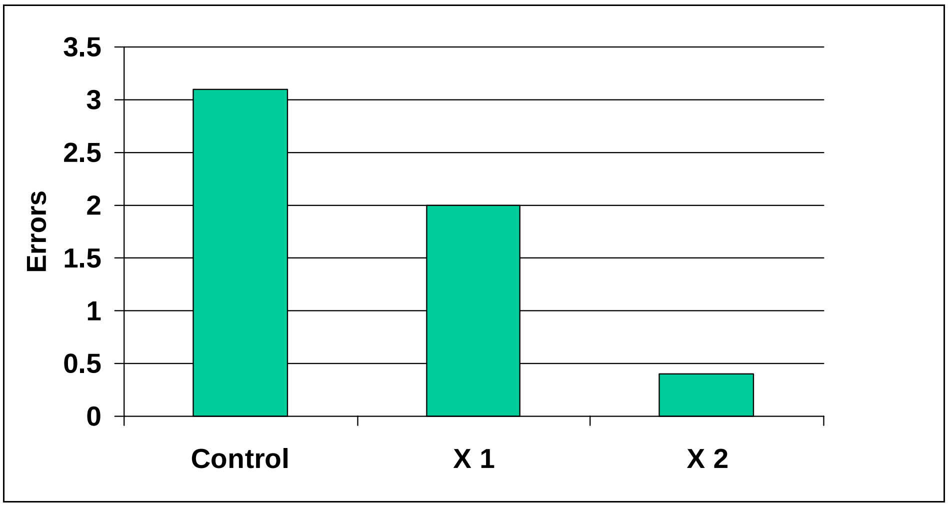

Figure 3: Errors in aerobatic training depending on previous PC training

The limited evidence leads to a cautious approach. The system we are presently proposing is to allow up to 50% of the training on FSTD which do not posses 100% fidelity but are above the minimum level. The minimum level is further defined by the requirement that it should not have any negative transfer of training, and allow the task to be executed in a similar way as in the real aircraft. So there might be a lack of adequate cues but no missing responses.

7 How does it look

The table below presents the subsystems that we distinguish; seven hardware models and nine software models. Visual and motion system are both separated in two models. The visual is separated in two parts: general visual requirement of resolution, contrast, polygons etc and Field of View as a separate requirement. This is very useful for military operations where full dome displays are often required for special tasks, but those tasks do not necessarily require the highest level of contrast. In the military we also have to accommodate for head steered presentation, a phenomenon which is presently not seen in civil simulation.

For motion systems the military simulators are not only using the well known hexapods moving base but also artificial g cues with bellows under the seat cushion and pressurization of the g-suit. Furthermore, it was more efficient to separate phase and motion requirements.

Typical military subsystems are ‘Military sensors’, ‘Threats and Targets’ and “Cooperative Players’. We have to realize that this entry is actually two dimensional; we have to specify all types of sensors, threats/targets and cooperative models per simulator.

Table 3: Overview of all simulator subsystems and qualification levels

Simulator subsystem	Hardware / Software	Levels
Instructor station	H	2
Visual	H	3 &+0.2 &+0.5
Field of View	H	5
Motion	H	3 & +0.5
Motion Phase	H/S	3
Sound	H	3
Cockpit	H	4 -0.5
Performance & control	S	4
Aircraft Subsystems	S	3 & +0.5
Avionics	S	3 &+0.2 &+0.5
Military sensors	S	2 &+0.2 &+0.5
Weather	S	3 & +0.5
ATC / C2	S	4
Threats & Targets	S	2
Cooperative models	S	2
Integration & Correlation	S	3 & +0.5

+0.5 & +0.2 means "in addition above the level itself"

The other side of the coin is the task list. We present here (a part of) the helicopter task list which was addressed first. We have distinguished 45 different tasks, not every task might be required for each pilot; every type of operation will require a sub set of this list. In the columns at the right the required level for complete flight replacement is depicted for the subsystems. The complete matrix is too large to incorporate in this paper. A similar list is required for the minimum level which allows for a 50% reduction in training hours.

The helicopter task list indicates which subsystems levels are necessary for training for which pilot qualification.

	IOS	Visual		Motion		Sound	Cockpit	Performance & Control	Subsystem	Avionics	Military sensors	Weather	ATC	Threats & targets	Cooperative models	integration
			FOV		Phase											
Maximum level	2	3 + 0.2 0.5	5	3 + 0.5	3	3	4 -	4	3 + 0.5	3 + 0.2 0.5	2 + 0.2 0.5	3 + 0.5	4	2	2	3 + 0.5
FSTD (x)	2	2	3	2	3	3	3	4	3	3	1	3	1	1	1	2
Military operations																
Hoisting	2	2	4	3	3	4	3	4	3	2	0	1	0	0	2	2
Under slung load operations	2	3	4	3	3	4	3	4	3	2	0	1	0	0	2	2
Roping, paradrop, abseilen hover jump	2	3	3	2	3	4	3	4	3	2	0	1	0	0	2	2
Sonar operations	2	2	2	2	3	2	3	3	3	2	0	2	0	1	0	2
Deck landings	2	3	4	3	3	3	3	4	3	2	0	2-3	0	0	2	3
A/G gunnery (= all weapon delivery)	2	3	5	2	3	3	3	3	3	2	0	1	0	1	2	2
Threat recognition and reaction		2	4	2	3						2					
Threat manoeuvering	2	2	5	2	3	3	3	4	3	2	2	1	0	2	1	2
Nap of the earth flying	2	3	4	2	3	2	3	3	3	2	0	1	0	1	2	2

Table 4: (Part of) helicopter task list vs simulator subsystem level required

100% Flight replacements

green	level of FSTD (x) is sufficient for task
yellow	level of FSTD (x) is NOT sufficient for task

This example shows that this specific FSTD(x) can be used for 100% training of sonar operations.

8 Where do we stand

The MAA-NLD initiative started mid 2007. Presently the draft MAR-FSTD for helicopters (MAR-FSTD H) is completed for review. The amount of training value (50 or 100%) and the requirements for the subsystem levels will be discussed with instructors (both flight and simulator) and simulator experts. Practical experience will be used to adjust the requirements.

We plan to start implementation in 2009 and also rate the different Dutch military helicopter FSTDs in that year. The next step is the MAR-FSTD for fixed wing aircraft. This regulation is of course completely in line with the MAR FSTD H. The differences are the task list and we also use the JAR FSTD A as reference. This work will probably be finished 2009

8.1 Open Issues

As discussed earlier, there is a lack of knowledge about the minimum requirements to be able to train in an FSTD. The present, quite binary approach, 50%, 100% or 0% reduction in flight training should be refined to optimize training. We encourage more studies in this particular field.

9 Conclusion

With our present effort we have set the first steps to regulate military simulator training, in a similar but still different way as in civil aviation. The military training is complex, expensive, but also extremely important. With our refined rating system, and our task oriented approach we give the operator the opportunity to get the maximum benefit out of his existing training assets, furthermore, it enables him to weigh upgrades of the simulator against the reduction in required flight hours.