Design of a Reference Training for Simulator Specification and Syllabi Optimization for the Defence Helicopter Command

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ABSTRACT

Military organizations not only train for safe operations, but also for combat readiness. To acquire and maintain combat readiness, continuous training is needed. Live training only provides this partly, as it is restricted by for example budgets and weather, as well as availability of platforms or training ranges. Simulations can provide training without the live constraints but have constraints of their own. In this paper we advocate a competency-based approach to design a training outline that does not take the live or simulation specific constraints into account. Per training sortie, it can be determined whether live or simulation would be the preferred training platform and what kind of requirements those platforms should have to meet the objectives. While the idealized training outline (blueprint) may never be feasible in practice, it can be a reference to inspire development of actual future training syllabi for live or simulation training systems.

The Defence Helicopter Command (DHC) of the Royal Netherlands Air Force (RNLAF) is in the process of a major training system revision, including the conversion towards a fully integrated multi-ship multi type helicopter training simulation capability. The approach towards an ideal reference training has been applied to support the DHC training system revision. This generated optimal training blueprints that functions as a reference design, a benchmark for future decisions on syllabus design and simulator usage. This encourages the implementation of competency-based training and supports identifying simulation capability requirements in a future proof and refreshing new way. The reference blueprints have been defined for DHC AH-64 and CH-47 flight- and aircrew.

The method of designing a competency-based reference training blueprint and defining training media requirements will be discussed in this paper. In addition, main considerations, results of training blueprints, simulation needs and learning points from the DHC training revision project will be discussed.

ABOUT THE AUTHORS

Anneke Nabben is training expert in the area of aviation training. She has a M.Sc. in Educational Science and worked for KLM and Airbus before she started at NLR in 2010. As senior project manager Anneke is responsible for a diversity of projects in the area of training concept development, training needs analysis and training (re) design including the enhancement of media use and definition of user requirements for training device such as simulators, including the use of AR and VR.

Dr. Jelke van der Pal is Senior Scientist at the Royal Netherlands Aerospace Centre NLR. After obtaining a Ph.D. in educational science, he has been active in aviation training R&D projects for the Royal Netherlands Air-Force, industry, and in international collaborations (NATO and EU funded projects). His focus is on improving the training design cycle for competency based training and personalized training. Currently, he is working towards modelling of retention within the scope of personalized training.

Major Roland Blankenspoor has been in service for 30 years. Being a Flight and Weapon Instructor, more than 4000 flight hours and 9 deployments worldwide he is one of the Senior Pilots of the Defence Helicopter Command. Major Blankenspoor is currently Head of the Multi Ship Multi Type Simulator Center.

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INTRODUCTION

The Defence Helicopter Command (DHC) of the Royal Netherlands Air Force (RNLAF) is in the process of a major training system revision, including converting to a fully integrated multi-ship/multi-type helicopter training simulation capability. Building the optimal training system requires an objective and thorough training need analysis and an idealized (visionary) training design. Achieving an idealized training design requires innovative thinking. But equally important, practical limitations should be ignored to a considerable extent to ensure the design can truly reflect the ultimately desired training with, for example, unlimited availability of personnel, training devices, and training areas. To develop idealized syllabi for qualification as well as continuation training, we have extended our competency-based training design approach for qualification training (Van der Pal et al., 2009) to continuation training. The resulting idealized syllabi can function as reference for strategic decisions concerning the training system or investments of training devices.

CONSIDERATIONS

The ideal training design is the starting point for determining the most effective training devices or requirements. The ideal qualification training consists of an optimal sequence of different sorties. This sequence has been defined by applying a "whole task" training principle, such that all competencies, as defined in a training needs analysis, are sufficiently addressed and practiced with sufficient variation. To determine which training devices are optimal, we identified the requirements for each sortie in the syllabus. For example, in a specific sortie, is it important that weapon behavior of the training device is specific and realistic, or can the weapon behave in a more generic way and still meet the training objectives? This activity leads to an extensive identification of user and functional requirements for approximately 50 functionalities of the training device per envisioned training sortie. Applying the approach requires consideration of three factors in performing this analysis: 1) practicability of the analysis, 2) subject matter expert (SME) experience with simulation, and 3) SME familiarity with whole-task training. As for the practicability of the analysis, the amount of input requested should not be extreme. This because available SME time is scarce, but also because large numbers of questions can cause a variety of biases in the estimates. To ensure practicality, a focused approach has been chosen. Requirements for training devices in this stage do not need to be complete, but only highlight the most critical aspects. Specific attention is required to ensure the limited or negative experience with legacy simulators does not affect expectations for future systems.

Working with new training concepts, future simulation options, and estimates about training needs and simulation requirements is not easy for anyone and therefore contains inherent uncertainties. Although always asking estimates from multiple SMEs, various biases need to be prevented or minimized. The results, nevertheless, contain a significant margin of uncertainty. Therefore, the results reflect a broad outline, a guide for future decisions. This document, which is in principle supported by operational pilots, loadmasters, and instructors may have a role in formulating training and simulation vision and long-term decisions regarding simulation. Through recording of experiences with the new training approach and simulation tools, the training and simulation vision can be further specified and decisions with less uncertainty become possible.

CONSTRUCTING THE IDEAL DESIGN

Design Approach

In a series of workshops with pilots and loadmasters in 2017 and 2018, a training needs analysis was performed and 'ideal' bleu print of mission qualification training (MQT) training and continuation training (CT) were drawn up. These are syllabi "blueprints" that do not consider organizational and technical bottlenecks that typically occur with a training plan and its implementation. The syllabi were designed to employ modern training principles and accommodate the wishes of those involved in training; they reflected actual training needs per aircrew function, without taking into account restrictions of equipment, simulators, or training areas. Additionally, these syllabi did not attempt to coordinate training for different personnel. For example, CH-47 pilots and loadmasters often need to train together but have different training needs. A sortie that offers good training value for a pilot may not provide good training value for a loadmaster and vice versa. The current approach does not optimize the planning process; it merely reflects the uncompromised needs per aircrew function.

NLR facilitators provided the approach and explained the concepts for optimal training before drawing up the ideal syllabi. The academic basis for this approach is derived from Van Merriënboer's 4C/ID model (Van Merriënboer & Kirschner 2007/ 2017), which has been tuned to military aviation by NLR (Van der Pal, Abma 2009). In this competency-based training approach for qualification training, the guiding principle is whole-task training whereby complete missions are trained from the start, initially simple and with considerable instructor support. The mission context becomes more complex with each module. The increased complexity is structured by varying a range of complexity factors, which are determined and classified by SME from DHC. From a large set of identified complexity factors (including weather, threat level, and contingencies), about 5 are usually sufficient to define the level of difficulty for the training modules. In order to achieve smooth performance during the whole-task sorties, part-task training (sorties or computer-based training) can be scheduled for basic operations and tactics, techniques and procedures (TTPs). This will also gradually reduce the need for instructor support during the whole task sorties.

For an ideal MQT, we assume the end state is a fully combat ready pilot / loadmaster for all missions and situations. All competencies, proficiencies are up to standard to achieve operational goals. The young pilot / loadmaster may be combat ready, but the competencies have not yet been "ingrained" and consequently they are subject to faster skill decay. He will therefore need more practice in the CT than experienced pilots / loadmasters to remain combat ready. Nevertheless, the ideal CT starts with the situation that everyone is combat ready; there are no proficiency lags or training gaps. Because the level of skill decay is not the same for everyone, even within the same experience group, the most ideal CT is a personalized CT where every pilot and loadmaster is offered the right experiences at exactly the right time to ensure competence retention. The ideal retention intervals for such personalized CTs are therefore related to the individual moment when the various tasks and competencies are just before they are no longer up to standard. Ideally, the proficiency / performance of each pilot and loadmaster should be determined continuously, preferably in an automatic, objective manner. Due to technical and organizational limitations, this is not yet feasible. For the current objective, a less accurate, but workable approach is to question the pilots and loadmasters about the period after which a "minimal loss of proficiency" is perceived or estimated (Arthur et al, 1998). For several reasons, this initial estimate is rather crude and somewhat unreliable, and some of the resulting individual CTs may be extreme (unrealistically few or many sorties per year). Therefore, in the current project, we did not aim for personalised CTs yet, but created one CT for less experienced and one CT for experienced pilots/loadmasters. By using the average or first quartile of the estimates of a larger group, the extreme estimates are levelled out. The average skill decay is taken as the starting point for the experienced group; for the less experienced group the more conservative first quartile of the skill decays is used. Two reference CTs can then be built with this. The CT for the average experienced pilot or can be seen as the standard which will apply for the majority of pilots. The CT for the more demanding (because short skill decay periods) less experienced pilots / loadmaster can contain many sorties, but this only applies to a small group.

The offered concept for CT is to use complex missions for readiness assessments and to prepare for this with specific part-task training. The whole-task training principle recommended as the guiding principle for the MQT is not effective or efficient for the CT because the pilot / loadmaster have already learned to apply competencies in an integrative manner. CT is therefore mainly about keeping track of specific part-tasks that deserve extra attention, while maintaining the integrative competencies of the larger scale missions.

The ideal syllabi can be used as a frame of reference for drawing up of the final realistic syllabi and for drawing up requirements for training resources. Having the ideal picture in mind, without taking all limitation in mind, provokes visionary thinking and results in more advanced and progressive solutions in the final training design.

Results Ideal MQT

Because of the wide variety of training requirements for different aircraft and positions, the resulting MQTs vary greatly. For the ideal MQT of the AH-64 copilot, the whole task principle is applied quite exhaustively. Modules increase in difficulty, with different missions being trained each time and with TTPs divided over the sorties. The ideal MQT for the CH-47 pilot is largely organized from the TTPs. The first module is "basic", with a strong TTP focus. The whole task missions are introduced in an advanced module, which also contains TTP specific sorties that are performed under more complex conditions. Other modules focus on environmental factors such as mountainous terrain or difficult geographies. The ideal MQT for CH-47 loadmaster is initially built from TTPs and loadmaster specific tasks. The first modules are similar but increase in difficulty. Each module contains several night and mountain sorties. In the last module, the tasks are trained within mission contexts.

The difference between AH-64 and CH-47 training shows that the CH-47 community has a greater need for part task training than the AH-64 community. This is partly due to the fact that the CH-47 has more TTPs to train than AH-64. A greater share of TTP specific training is not necessarily inconsistent with the training design approach. When whole task missions are carried out (or demonstrated) prior to the TTP specific training, the part tasks become meaningful within the entire mission and operational context. While a stronger whole task training design in the early phases of training would have been possible, the SMEs deliberately opted for an intermediate form that we have labelled ‘integrated part task'. The sorties have certain whole task aspects, in which complexity factors are included in a controlled manner, while the part task aspects are the prime focus of the training. The latter CH-47 MQT modules have a standard whole task structure.

Results Ideal CT Design

As discussed, for all functions, two CT syllabi are drawn up from the skill decay estimates: one for the average experienced operator and one for the less experienced and more demanding operator. Nearly all mission types are practiced as a whole task at least once a year. The syllabi are built conservatively, so that there is a high likelihood that everyone in both groups can remain continuously combat ready. However, the practical feasibility of this "ideal syllabi" has not been determined. There is room for further optimization of the syllabus (for example, practicing more than three TTPs in a single sortie). In addition to the category "part tasks," which is specifically intended to practice various TTPs, preparations for proficiency checks, and the close formation flying sorties are also regarded as part tasks. The principle that everyone is fully proficient and combat ready, which means that maintaining proficiency can largely suffice with part task exercises, seemed somewhat counterintuitive for the SMEs. There is a tendency to maintain competencies (including the TTPs) especially within complex missions. This has already been slightly adjusted in consultation with the SMEs, but for all syllabi the proportion of part task exercises can possibly be increased.

As a result of the skill decay self-ratings of the pilots, the ideal CT requires relatively few night flights, even though the operational situation is primarily focused on night flights. Therefore, the SMEs have an understandable desire to add more night flights, even though this is not supported by the average skill decay estimations. Even the more demanding, inexperienced pilots expect to keep this competence up to standard with less than 20% being night flights.

It is also noticeable that the CH-47 pilots aim to practice less TTPs in the CT than the AH-64 pilots, while this was reversed in the MQT. This difference was unexpected. However, it is not required that the CT courses for CH-47 and AH-64 must be uniform with regard to part task / whole task ratios. Different skills have different retention courses. The set of TTPs differs between the functions and that may explain the different relationships between CH-47 and AH-64 communities. An additional explanation may be that because of the build-up of the CH-47 MQT, which focuses more on part tasks, these part tasks are more trained and therefore ingrained, so that less decay may be expected.

SIMULATION REQUIREMENTS

Requirement approach

From the ideal syllabi, requirements for the training resources can be derived. To do so for each MQT, experienced pilots and instructors (around 6 participants per workshop for each function) were asked various questions (around 60) about each training task. These questions concerned collaboration, visuals, sound, cues, controls, complexity factors and instructor operating station (IOS) requirements. Examples of the questions are: Is cooperation with other AH-64 needed? Is contact with air traffic control needed? Do you need all sensors? What aircraft behavior do you need? What weapon behavior do you need? For questions concerning fidelity, different levels of fidelity could be selected (see Figure 1). By analyzing all answers, the "big picture" of fidelity requirements (live, high-end or low-end simulator) per MQT was created.

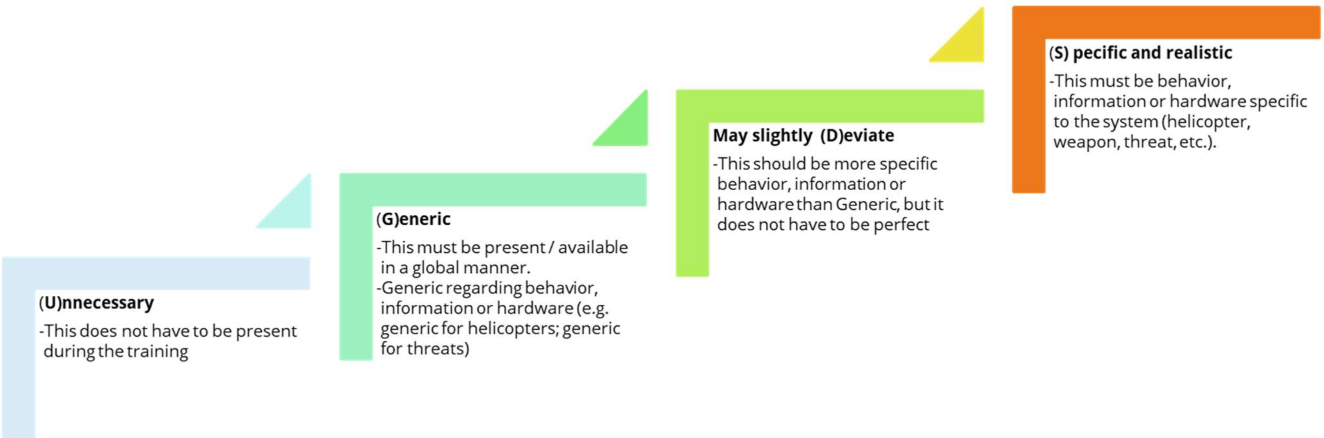

Figure 1. Fidelity requirements

In addition to the requirements derived from the ideal syllabi, requirements for training resources have also been derived from current documentation (e.g., tactical operation manual) and the experiences pilots have with current simulators. These requirements can be added to the requirements arising from the ideal syllabi and in this way provide a complete overview.

For CT, less time was available, and the experienced pilots and instructors were asked about their perspective towards a range of training devices for specific missions and tasks. Instead of deriving the most suitable training resource by analyzing an extensive questionnaire, now pilots and instructors could directly select the most suitable type of training resource, such as live training, full mission simulator (FMS), procedure trainer or desktop trainer.

For both the MQTs and CTs, the requirements during workshops were drawn up according to a consensus model whereby all experienced pilots and instructors could agree with the requirements.

Results: Simulation Requirements for MQT

In the analysis of the requirements per function (AH-64, CH-47 pilots and load masters), it is noteworthy that the requirements for joint training differ greatly per function. The CH-47 almost always requires crew training (rear and front crew together). Multi ship training is often required for pilots (both AH-64 and CH-47) but not for load masters. Finally, there is little need concerning multi type training, but for the AH-64 this is considerably higher than for the CH-47. We go into more detail on the training requirements for the different type of trainees below.

AH-64 Requirements

Because all sorties require many flight specific-realistic features for training as well as motion cues (often 'generic' or 'may deviate'), it is necessary to fly live or to consider highly advanced motion-based FMS. However, because it is also considered important to present the human physical load (cockpit climate, suit, helmet) realistically during the MQT, the use of FMSs was not obvious because it can cause transfer problems and requires many very expensive simulators. All sorties could be offered live, although it is unlikely that all conditions and threats will have the desired realism. A combination of live and motion-based FMS then offers more options. This is also consistent with the comments made by experts during the development of the MQT syllabus: “as the syllabus progresses, more simulation can be used”.

For almost half of the sorties, instructors must be able to control the scenario in order to realize the ideal syllabus. If necessary, the instructor must be able to adjust the weather, use jamming or spoofing, pause the scenario or provide detailed feedback / instruction during the flight. However, this does not go well with live training. Therefore, the determination of the required live training has been adjusted to the calculated absolute minimum in order to meet both the flight as well as the instructor requirements. In the resulting ideal syllabus, approximately half of the training (41%) should be done via high-level simulation and half of the training (59 %) should be done live.

CH-47 Pilot Requirements
Many training sorties require specific realism on only part of the requirements. However, because movements or other physical loads are considered essential for this learning phase, the desire of the SME’s is to have most of the sorties (90%) live, with a minimum of one third (32%), when a very realistic motion-based FMS is used.

The SMEs also want instructors to have advanced control capability most of the time (96% of the sorties), which is not compatible with live training. If we take into account the instructor tool requirements while respecting the requirement of the minimum of live training, around one third (32%) of the sorties should be flown live according to the ideal syllabus.

CH-47 Loadmaster Requirements
Loadmasters need motion cues for effective training. In almost all sorties, motion cues should be present, but it only needs to be realistic in two-thirds (65%) of the sorties; in other cases, it may also be generic or slightly different. This is not always about movements of the device, but often about movements of loads both internally (sliding) and externally, where the visual aspects of the movement are most relevant. For example, a fast rope must behave as it behaves in the real-world when the device is moving. Specific and realistic visual and motion cues must be experienced at least five times (9%) simultaneously. Because it is considered important to always offer human physical load (cabin climate, suit, helmet) realistically during the MQT, a high percentage use of rear crew trainer or mockup was not acceptable to the loadmasters. However, when a good mock-up is available, many sorties can be carried out, especially when it concerns a high-end mock-up (mockup +) with visual simulation of the outside image and possibly with haptic feedback, such as the feel of the cable used in hoist operations. Internal cargo is placed during flight preparations in one-third (31%) of the sorties. These can be practiced in a "regular" mock-up. It is not necessary that specific sorties must be performed live or with predefined realism, as long as the ratio specific-realistic versus generic or "slightly deviating" realism is good. Loadmasters have more interest than pilots in realism of tactical characteristics such as behavior of ground units, enemies, and bystanders (in about half of the sorties). In the long term, this is easier to achieve with simulation than with live training.

Just like pilots, loadmasters require advanced instructor controls available for all training sorties. Scenarios must be adaptable and the trainee must be able to be properly monitored. For the live sorties, this requirement creates a conflict for the LM between student and instructor needs. If we take into account the instructor requirements (all types of advanced instructor tooling), but respect the requirement of an absolute minimum of 9% live, this will also be the maximum percentage of live sorties.

Results: Simulation Requirements for CT

Experienced pilots and loadmasters (between 2-5 SMEs per function) were asked to indicate per type of mission / task which type of training resources are necessary to achieve the ideal training. The SME’s could select the following groups of resources:

- FMS: Simulator that is realistic enough to effectively train flight technical and tactical tasks (if the simulators are coupled) within complex missions and under complex circumstances. The FMS are not required to be motion-based but may be and can be used in multi-ship or multi-ship / multi-type configurations (a flight-technically realistic FMS can also be used as a single ship for level I training, but then it is actually a procedure trainer, see below). For the rear loadmasters this category means a rear crew trainer with a motion system and realistic outside visuals “Mockup +” where loads behave realistically.

- Procedure trainers: For flight tasks, the procedure trainers must have realistic visuals and flight models for the pilots; this is not necessary for the loadmaster. The mockup is the same as the mockup + but without motion and outside visuals. This allows procedures and flight-technical / LM-technical part-tasks to be trained realistically under possibly complex flight conditions.
- PC-based sim: With low-cost networked simulation, no flight or LM technical tasks can be trained, but tactical tasks, such as the tactical flow and coordination of complex missions and under complex tactical conditions, can be practiced.

For each mission type, the SMEs were free to choose other means and could make specific demands on these future resources if relevant. Below the general results of the analysis are given without getting into the details of how requirements per type of mission or task.

AH-64 Requirements
Although the less experienced pilot needs more than 2.5 times as many sorties than the experienced AH-64 pilot, the distribution of missions across both CTs has the same need for training resources. It is striking that there seems to be little use for stand-alone procedure training. For a possible FMS with motion, it was recommended to make it very realistic so that it can be used as a replacement of flight time, as required by military regulations However, at this moment this is not directly used because the preference is live training. It is possible that in the future simulators will become so good that more simulated training will be feasible, but with the current experience and expectations for the future, 50% is considered to be the maximum achievable. SMEs also expect that "negative transfer" can occur because the threshold for taking risks in the simulator is higher than live. But as long as at least 50% is flown live, the SMEs do not think an FMS with motion is necessary. Specific requirements are the following:

- It is important to be able to estimate depth properly and to use vibrations, g-forces and physical load in the flight feeling. This has to go live for the time being.
- For training with a focus on tactical elements and cooperation with ground troops or CH-47, FMS without motion is an option. Sensor and weapon use can also be trained with this. Enemy behavior, bystanders and vehicles must be well modeled.
- The more cognitive aspects of decision-making, coordination and radio management can be trained in PC-based environments. The controls and sensors must be more platform-specific and the comms must be realistic (evasive maneuvring calls can be trained well).

CH-47 Pilot Requirements
For all CH-47 pilots (experienced and less experienced), more than 1/3 of the sorties should be flown live. A procedure trainer and a PC-based sim can maintain a few mission types. With an FMS, more than half of the sorties can be flown. Less experienced pilots want to use the multi ship multi type configuration more often than the average experienced pilot. Just over half of the FMS sorties must be flown with motion.

It is important for all sorties that the rear crew be present and able to perform their tasks. The same requirements as defined for the MQT apply to the FMS during CT, i.e., the flight controls devices, the instrument panels, sounds and the environment must be specifically realistic. Radios (and quality connection) may be generic. Movement must be specifically realistic. For the FMS sorties where no motion is required, the chairs must provide feedback (vibrations). The following comments have been made for specific missions:

- Surveillance and reconnaissance can be carried out on procedure trainers, provided the visuals offer full visibility and good input from load masters is possible (rear crew trainer with good visuals, see further requirements under load master).
- For external load sorties on FMS, the aerodynamic model and wind models must be specifically realistic. Procedural aspects, especially communication, can be trained on a procedure + rear crew trainer.
- Joint personnel recovery training on an FMS requires good visuals, with a rich environment and depth perception.
- Forward area refueling is purely procedural and does not require a realistic simulator.
- Escort and convoy escort especially require good visuals.
- Vehicle and boat interdiction and sniper ops must go live a few times and furthermore this requires good motion cues. Procedures can be trained on an FMS without motion.

CH-47 Loadmaster Requirements
For the CT, it is especially important to practice procedures in realistic cabin situations such as live or mock-up with active tools and real loads. To achieve sufficient training value, haptic feedback must be present, such as the feeling of lashing internal loads. For most of the CT, these requirements are not considered to be feasible for quite a while with simulation. Live training is often required for the combat ready loadmaster.

Mock-ups with active tools are considered useful for some tasks, but a role for virtual environments is not considered necessary for the combat ready loadmaster. These results deviate greatly from the provisions for the pilots. The loadmasters involved in the CT training resources analysis were skeptical about (future) simulation tools and in our opinion took this too much into account in their trainer requirements for an ideal CT.

IDEAL SIMULATION CONCEPT FOR THE IDEAL TRAINING SYLLABUS

Distribution of Training Between MQT and CT

Because there is a difference in the required resources for MQT and CT, it is important to have insight into the distribution of training over the entire career of the pilot and loadmaster. Only then a blueprint of the required simulation concept can be made. In order to make this distinction, an allocation key has been used in consultation with DHC and is shown in Table 1.

Table 1. Percentage Flight Hours After Initial Qualification

Phase	
(Mission) Qualification training	5%
CT less experienced	30%
CT experienced	65%

Using these numbers, an overview has been generated of the required simulation and live training resources over the entire pilot and loadmaster career. The position of the desired distribution of training resources in percentages of the total number of flying hours over the career of the pilot or loadmaster is mapped out below for each position. Where possible, the percentages of single ship, multi-ship or multi-ship/multi-type are indicated per resource for each position.

The overview shows that some training tools require less than 5% of flight hours. It concerns FMS motion for the AH-64, procedure trainers for both AH-64 and CH-47 pilots, desktop (PC-based, VBS-like trainers) for CH-47 pilot and a high-fidelity rear crew trainer (mockup +) for the loadmasters. In principle, these resources do not have to be purchased if there is a reasonable alternative. We plead to make an exception for the AH-64 FMS motion, the desktop trainer for CH-47 pilot and the Mockup + for the loadmaster. The reasons for this are that many SMEs value motion-based simulation for certain workouts or exercises. However, scientific literature shows little support for the use of motion systems (Davidson, 2018; Go et al., 2003; Winter et al., 2012). Performance and learning effects are also achieved without movement cues; moreover, hardly any research has been conducted into the effects of movement on learning processes. Frequent use of incorrect simulation can result in "negative transfer" and has also led to accidents. It is not known whether this also applies to the lack of motion cues. The use of motion cues is still "inconclusive" after more than 50 years of simulation. However, the importance that SMEs attach to motion cues may be too strong, but we believe it should be taken seriously. This is also relevant from a simulation acceptance perspective.

Overview Ideal Simulation Concept

AH-64 FMS motion: Although the MQT takes relatively few hours of the total training time, the numbers show that around half the MQT is better off with a motion-based FMS and a fixed base FMS is not considered an alternative. During the learning process in the MQT, it is important to fully offer the flight technical cueing, also during the more tactically oriented training. Because a motion-based FMS is needed for MQT training, motion based is also chosen for the AH-64. An additional advantage is that for the AH-64E, which is IFR capable, the IFR currency checks cannot be performed live, but are performed on the FMS motion. Since the total size of fixed and motion-based FMS training is almost half (including little procedure training), there seems to be room for several FMS two-ships, which do not all have to be motion-based.

CH-47 FMS simulator: About half of the FMS training (with or without motion platform) can be performed without motion cues. The concept therefore includes two “HiFi motion” and “Hifi” simulators. Simultaneous use of four CH-47 devices is almost not required. Because the CH-47 pilots only require about one-third live training as the ideal, we assume that more than 2 simulators will be needed to meet the training need, especially because the demanding inexperienced pilots need a lot of practice. To avoid planning bottlenecks, four simulators is desirable, two of which may be without a motion platform. A number study will have to show whether this assumption is correct.

CH-47 pilot desktop trainer: There is little need for desktop training for the CH-47 pilots. However, since the need for an AH-64 desktop trainer seems to be large enough to justify the purchase, these desktop trainers can just as well be used for the CH-47 because the additional setup costs are relatively low if the same simulation engine and models are used. However, a generic CH-47 flight model and specific controls must be purchased. The use of CH-47 desktop trainer provides good opportunities for practicing communication and coordination in tactically complex scenarios and can therefore allow the use of the (expensive) FMS for more demanding tasks. Additionally, desktop trainers are very accessible. A desktop trainer is therefore also included in the simulation concept for the CH-47 pilot as a training tool.

High fidelity, motion-based rear crew trainer (mockup +): The loadmasters mainly need a mockup to practice the flight preparation. Tactical aspects need to be trained live according to the loadmasters. Nevertheless, to accommodate all FMS sorties for CH pilots with realistic rear crew interaction, we propose to use a fully-capable rear crew trainer. We also believe that rear crew trainers will be further developed in the coming years to offer tactically meaningful training for load masters (e.g., with external loads and hoist operations). We assume that the proportion of rear crew trainer for the loadmaster in the future will be higher than the current use as expressed use by the loadmaster.

With these considerations and the image that the training resources provide about the "lifetime career" of the pilots and loadmasters, we arrive at the setup shown in Figure 2 for a simulation concept[1] for CH-47 and AH-64 helicopters.

1

Level I/II Crewmember/crew level training (single ship)
Level III Section level training (multi ship)
Level IV Flight level training (multi ship and / or multi type)
Level V Squadron level training
Level VI Above squadron level training

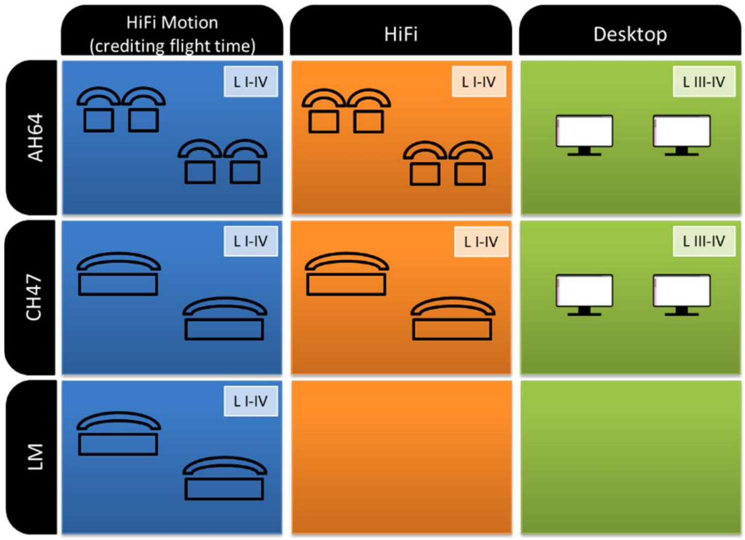

Figure 2. Simulation concept

All training systems for pilots must be connectable to each other. The rear crew trainer must be connectable to all CH-47 training equipment for the pilot. The FMS without motion ("HiFi") can be used for Level I to Level lV training, and possibly higher. However, the MQT will only use HiFi Motion for Level l and ll. So Ll and Lll training for HiFi only concern the CT.

Note. This simulation concept does not take into account the number of people to be trained. This is a minimum set-up of the type of simulators and the minimum number required for tactical training where simulators must be linkable. Depending on the number of pilots that must remain trained and current, several of the same simulators may be required. The number of simulators to be purchased can be determined in a number study.

DISCUSSION / LESSONS LEARNED

While the most optimal design does not need to be fully feasible, it remains important that the involved stakeholders, in our case helicopter pilot and loadmaster communities, support the resulting optimal training design. Therefore, the main decisions during the training needs analysis and design are carried out by pilots and loadmasters themselves. NLR provided the new training concepts, facilitated the process, and documented results. This way of working can be difficult and time consuming. It takes time and requires trust to create an open mind and gain acceptance from the community. An additional difficulty with this approach is that the same SMEs (pilots and loadmasters) are not always present during the facilitation workshops. This is a logical consequence of working with operational SMEs that have multiple priorities; however, it does not accelerate acceptance and a common vision. As a result, the competence profile and the applying the design principles has taken a long time and sometimes deviates from the NLR training design approach offered. However, acceptance of the product is always a more important starting point than rigorous compliance with the design methodology.

Further, limited or even negative experiences with simulation had an influence on the selection process of training device requirements. Often fidelity requirements as close as possible to the real platform were selected, which results in live flying. On the other hand, the requirements in which the instructor can influence the scenario as much as possible were also selected. Unfortunately, live flying and strong control over the scenario by the instructor are often mutually exclusive. This was a challenge when formulating a simulation concept. It has also been shown that unfamiliarity with whole-task training also influences selection of requirements, which is expressed in preference for flight technical requirements over tactical training requirements. These factors affect the results as shown in this report.

Regardless the discussion above, the principles of whole task training and part task support have been embraced and used in the current training syllabi. The MQT's have been revised, using the ideal training syllabi as a reference. After the delivery of three MQT's new style it can be concluded that students like the whole task approach and it increases motivation. Additionally, the students indicate that they better understand the 'big picture'. Nevertheless, it is still difficult to find the ideal mix between whole task and part task training, especially for the CH-47. This is understandable, knowing that the ideal syllabi, used as a reference for the MQT new style, are not taking any practical (real-time) restrictions into account. Another promising result is the motivation students get by joint/combined training. Due to Corona restrictions, the current MQT is not followed in in Ft. Hood but it is in the Netherlands, which gives the opportunity to combine training with Cougar pilots and loadmasters. This has resulted in a huge motivation boost for the trainees. This is a good support for the multi-ship/multi-type simulation environment, in which whole task combined training will be frequently deployed, that is currently being developed and that will be fully operational in 2024.

Finally, looking back at the project, the combination of operators and scientists has proven to be a fruit full approach to achieve success. It showed that DHC was already doing a good job and, additionally, gave progressive and positive new insights, relatively easy to deploy, resulting in highly motivated flight and aircrew.

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