European Aviation Safety Agency

CONCEPT PAPER [DRAFT 1.5]

FOR RMT.0599 'EVIDENCE-BASED AND COMPETENCY-BASED TRAINING'

Alternative training media and methods

EXECUTIVE SUMMARY

[Work in progress

EARLY DRAFT FOR THE EBT WORKSHOP.

THIS DOCUMENT IS NOT THE FINAL CONCEPT PAPER. PROOF READING NOT PERFORMED.

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1. Introduction and scope

The European Aviation Safety Agency (EASA) (hereinafter referred to as the 'Agency') identified the need to ensure that aviation personnel have the right competencies and training methods to cope with new challenges. This is one of the most significant systemic issues in the European Plan for Aviation Safety (EPAS), 2016-2020. The safety priorities identified in the EPAS are addressed by specific actions[1] in the Agency's rulemaking or safety promotion programmes.

Recurrent practical aviation training is currently primarily focused on the use of Flight Simulation Training Devices (FSTDs), including Full Flight Simulators (FFS). Computer Based Training (CBT), or e-learning, is also employed, but mainly as part of the academic training elements, in addition to or as replacement of more traditional training methods. In recent years, there has been an increase in development of additional training devices for practical training. Some of them can be qualified under existing EASA regulation, such as Flight Navigation and Procedures Trainers (FNPT) and are often incorporated as part of a suite of training tools in type training courses to consolidate the knowledge and skills before using the FFS. However, there is a wider range of additional complementary practical training devices that can be used in order to complement and ensure optimal use of the FFS, which has not been fully explored as of yet.

In order to allow a structured discussion of the rulemaking group 0599[2], the Agency decided it is appropriate to publish a concept paper and allow the stakeholders to comment on the concept beforehand. This will allow improvement of the concept, provide transparency to the industry and allow them a better basis for their business decisions.

1.1. Scope

The scope of this concept paper is related to 'recurrent training and checking' for commercial air transport operations (CAT). This may include requirements in ORO.FC Regulation (EU) 965/2012 and Licence proficiency check (revalidation and renewal) Part FCL – Appendix 9 - Regulation 1178/2011

This concept paper exclude the issues and problems related to flight simulation training devices (FSTD) updates for CS-FSTD (A) &(H) where a dedicated Rulemaking task RMT0196 'Update of flight simulation training devices requirements' was initiated by the Agency and which started in 2016. This concept paper also excludes the issues and problems related to initial type-rating requirements contained in Reg. (EU) 1178/2011. SUBPART H - CLASS AND TYPE RATINGS

1 SYS5.1 and SYS5.3. 'Two actions (…) focus on modernising training methods and competency provisions across several domains: flight crew licensing, operations, maintenance and ATM/ANS. New training methods like competence based training (CBT), Evidence-based Training (EBT) and distance learning are being evaluated, and training standards will be adapted in the coming years as necessary.' (European Aviation Safety Plan 2014-2017)

2 RMT0599 'Evidence-based and competency-based training' started in January 2016.

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2. Description of the issue

2.1. Identification of the issue - General

There are several challenges facing the industry with regard to performing training tasks, from the perspective of the training demands, as well as from a business perspective. The traditional training syllabus is rather prescriptive and leaves little room for tailoring or scope for optional training content and media. It is anticipated that there will be increasing training demands as the environment changes, aircraft systems develop further and the flight operations evolve. Pilot skills will have to adapt and in addition, it is important to accommodate the learning styles of younger generations of pilots. It is therefore interesting to consider how to implement alternative training tools to tailor training to pilots' individual needs and to take into account evidence-based operator requirements in order to set new regulatory requirements. The introduction of alternative training tools may for example serve to restructure the capacity of FFS, in favour of FFS time for flight critical competency training and pilot assessment. This stretches the possibility to practice varied realistic and line oriented scenarios, which allows improved mitigation of the operational risks. Using different training tools is important; it gives the opportunity to practice different situations and to generalize the trained skills and competencies to other situations. This mitigates the risk of non-transferability

2.2. Identification of the issue – Regulatory

2.2.1 Evidence-based training (EBT)

Following the Rulemaking program 2016-2020[3], the Agency decided to implement EBT[4] and published an ED Decision 2015/027/R 'Implementation of Evidence-based Training within the European regulatory framework'[5] approving the mixed implementation of EBT. It subsequently published a concept paper for EBT[6] and initiated the RMT.0599[7] 'Evidence-based and competency-based training' (review of ORO.FC)[8] to facilitate a full deployment of EBT (baseline as well as enhanced EBT).

Currently, the simulator training (FSTD) covered in the AMC1 ORO.FC.230 (a)(4)(i)(A)[9] requires all major failures of aircraft systems to be trained in a 3 year cycle. While this approach classifies malfunctions by aircraft systems, EBT provides a different perspective on malfunction training. 'According to the EBT philosophy, failures of aircraft systems and associated procedures are assessed as major according to their impact on crew performance[10]' and not according impact in the system. In EBT the malfunctions

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[3] Rulemaking Programme 2016–2020 Final 11 December 2015. https://www.easa.europa.eu/system/files/dfu/Final%20RMP%202016-2020%20v6%2020151210.pdf

[4] As described in the concept paper for RMT0599, the Agency will implement EBT on voluntarily basis.

[5] https://www.easa.europa.eu/document-library/agency-decisions/ed-decision-2015027r

[6] https://www.easa.europa.eu/document-library/terms-of-reference-and-group-compositions/tor-concept-paper-rmt0599

[7] RMT0599 started in January 2016 with the publication of the ToR followed by the first rulemaking group meeting in February 2016.

[8] https://www.easa.europa.eu/document-library/terms-of-reference-and-group-compositions/tor-concept-paper-rmt0599

[9] AMC1 ORO.FC.230 paragraph (a), subparagraph (4) Aircraft/FSTD training:
[…] (i) General
(A) The aircraft/FSTD training programme should be established in a way that all major failures of aircraft systems and associated procedures will have been covered in the preceding 3 year period. […]

[10] Explanatory note ED decision 2015/027/R 'Implementation of evidence-based training (EBT) within the European regulatory framework' and ICAO Doc 9995 Manual of evidence-based training paragraph 3.8.3

are arranged in clusters[11]. These clusters are built from a crew performance point of view and not from a systems point of view. Demonstration of proficiency in the management of one malfunction is then considered equivalent to demonstrated proficiency for the other malfunctions in the same cluster[12]. In this line, the ED Decision 2015/027/R GM1 ORO.FC.230 (a);(b);(f) for the mixed implementation of EBT already acknowledge this change in the philosophy of training. This approach is supported by the analysis of airline accidents and incident data over the past 30 years that has led airlines, manufacturers and regulatory bodies to conclude that between 70 and 80% of accidents and incidents have a contributing factor linked to crew performance. In consequence, the EBT approach (crew performance instead of systems approach) explained in the previous paragraph better mitigates the operational risks. EBT use also the malfunction clustering to focus the FFS training content to enhance pilot skills, both human and technical, and at the same time it improves crew performance and proficiency.

Nevertheless, it is recognized that the traditional approach to recurrent training (training all major failures of aircraft systems[13]) has proved to be safe. Together with other mitigation measures, the aviation industry is today and without doubt the safest global mode of transport. Therefore, the new approach for training –EBT- should maintain the review of all aircraft system but allow flexibility in in the use of alternative training means. In this context, new proven technologies provide help to resolve this issue. This idea is fully aligned with ICAO Doc 9995 paragraph 3.8.2 "all malfunctions not covered by this characteristics continue to require review and appropriate procedural knowledge training with different means than considered in the recurrent EBT training conducted in an FSTD"

This concept paper proposes a way forward and sets out a regulatory road map for this new approach in which it is ensured that all malfunctions of aircraft systems will be trained (using both FSTD and alternative training means) allowing room in the FSTD to effectively train pilots.

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[11] ICAO Doc 9995 Manual of evidence-based training

Table I-3-1. Malfunction characteristics and crew performance

Characteristic	***Description of required crew performance***	***Examples***
Immediacy	System malfunctions requiring immediate and urgent crew intervention or decision	Fire, smoke, loss of pressurisation at high altitude, failures during take-off, brake failure during landing
Complexity	System malfunctions requiring complex procedures	Multiple hydraulic system failures, smoke and fumes procedures
Degradation of aircraft control	System malfunctions resulting in significant degradation of flight controls in combination with abnormal handling characteristics	Jammed flight controls, certain degradation of FBW control
Loss of Instrumentation	System failures that require monitoring and management of the flight path using degraded or alternative displays	Unreliable primary flight path information, unreliable airspeed
Management of consequences	System failures that require extensive management of their consequences (independent of operation or environment)	Fuel leak
Note.— This refers to the case of recurrent training and assessment conducted in an FSTD qualified by the CAA at the appropriate level for recurrent training and assessment. Other malfunctions not covered by the characteristics detailed in 3.8.2 and 3.8.3 continue to require review and appropriate procedural knowledge training conducted in a less qualified but suitable environment (classroom, flight procedures training device, etc.), as an additional component of EBT. This is intended simply as a means of offloading the need to perform such training in a highly qualified FSTD, which has much greater potential benefit in other areas.		

[12] Explanatory note ED decision 2015/027/R 'Implementation of evidence-based training (EBT) within the European regulatory framework' and ICAO Doc 9995 paragraph 3.8.3

[13] See AMC 1 ORO.FC.230

2.2.2 Part-SPA training requirements

Operator's FSTD programs may require a slightly large number of approaches to be trained in a 3-year training cycle, especially when it is trying to develop line oriented FSTD sessions. The training requirements of ORO.FC.230 "recurrent training and checking[14] piles up with the requirements of low visibility operation[15], Performance Based Navigation (PBN) and other type of requirements associated to special approach operations (NVIS, EVS, HUD etc) resulting in about 50 approaches to be made in the FSTD in a 3 year cycle. This puts a burden in the efficiency of the training programs, and imposes unrealistic scenarios in the training delivery. Moreover, although the FSTD direct cost has decrease over the years, there are still some aircraft types where the cost of FSTD remains very high.

The FSTD provides a high fidelity environment in terms of interaction and replication of the real environment with high information fidelity. However, some of the requirements described above may hardly need any interaction with the aircraft, nor G forces may be needed, (eg SPA.LVO.120 approach to land in lowest minima with auto land, FCL Appendix 9 item 6.4[16]). Therefore, some requirements that currently need to be trained in an FSTD may be transferred to an alternative training means if the required fidelity is guaranteed.

Example possible optimized use of training media

The example is related to section 6, element 6.4 of the FCL appendix 9: "Landing(s) with visual reference established at DH following an instrument approach. Depending on the specific flight guidance system, an automatic landing shall be performed". Although it is a checking element and not a training element, the example helps to illustrate the argument:

This requirement in a CAT III B environment/NO Decision height implies that crews monitor the autopilot performing an auto land, this is true for most of the modern aircraft types. Therefore, the physical functionality of the controls, or acceleration fidelity may not be needed, while information fidelity and visual fidelity should be there. For this type of approaches, an immersive virtual reality device may be all that is needed for training. Therefore, the future rulemaking group may discuss credits to allow an increase of the validity period in the simulator if combined with an acceptable training means.

[14] Contained mainly in Regulation (EU) 965/2012 Annex III ORO.FC.230.

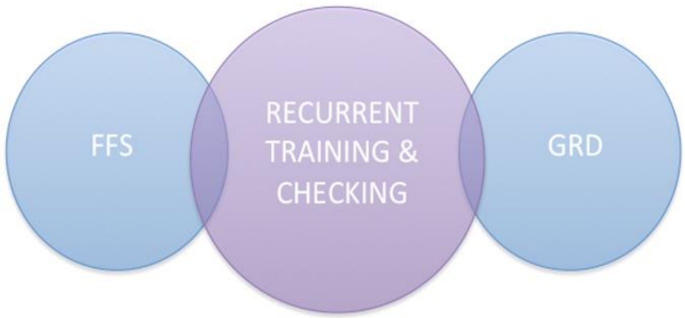
[15] Contained mainly in Regulation (EU) 965/2012 Annex V Part SPA

[16] MULTI-PILOT AEROPLANES AND SINGLE-PILOT HIGH-PERFORMANCE COMPLEX AEROPLANES, PRACTICAL TRAINING, ATPL/MPL/TYPE RATING SKILL TEST OR PROF. CHECK: "Landing(s) with visual reference established at DH following an instrument approach. Depending on the specific flight guidance system, an automatic landing shall be performed"

2.2.3 Enabling regulation

Regulation for recurrent training and checking generally uses a binary approach to training delivery. The regulator has observed that the training media used is either:

- FSTD/Aircraft, AMC1 ORO.FC.230 (a)(4), or
- Ground course[17], AMC1 ORO.FC.230 (a)(1) generally classroom or online presentation followed by a technical quiz.



This binary approach to training has two major consequences:

1- Economic pressure may led some operators to adopt the cheapest possible delivery method of training for ground courses (e.g. books, technical quizzes, static power point presentations etc.) This approach pushes the market to follow suit in order to reduce this competitive advantage[18]. Business cases for new and more expensive training tools such as FNPT, 360 Virtual Reality (VR), PC/Tablet simulation are therefore reduced. Approved training organisations (ATO) and Operators that are willing to invest in such tools, do not received back the returns they otherwise would receive.

2- Regulatory requirements have unwittingly overloaded simulator training sessions. When the need to implement and regulate a training item appears, the regulator is faced with a choice between the two extremes of training delivery. Either the traditional ground course which is assumed to be the least expensive (e.g. book, traditional classroom and technical quiz) or the most expensive form of training (i.e. FFS). This occurs because there is no regulation enabling other means of training (e.g. FTD, 360 Virtual Reality, tablet simulation etc.). Consequently, the FFS is used for training purposes in which the FFS is not always the most efficient and/or effective training device. This has progressively '*saturated FSS recurrent training programmes and created an inventory or "tick box" approach to training*[19]'.

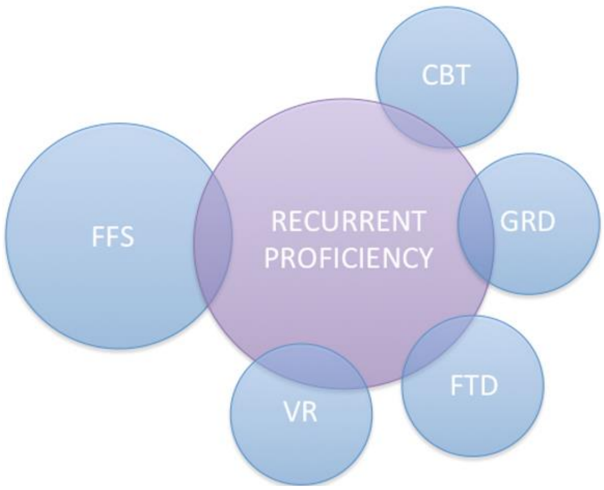
[17] Generally speaking CRM and safety and emergency equipment training are blended with ground course.
AMC1 ORO.FC.230 paragraph (a) Recurrent training should comprise the following:
(1) Ground training […]
(2) Emergency and safety equipment training […]
(3) CRM […]
(4) Aircraft/FSTD training […]

[18] The Quarterly Journal of Economics, Vol. 84, No. 3 Article "The market for Lemons: quality uncertainty and the market mechanism" 1970 (by Economist George Akerlof's Nobel prize 2001) and the monetary principle of Gresham's law can be used as an analogy, to explain the behaviour described above. However, the analogy is instructive, but not complete.

[19] Paragraph 1.1 ICAO Doc 9995 Manual of Evidence-based Training First Edition — 2013

2.3. Identification of the issue –modernizing pilot learning philosophy

Nowadays is widely accepted that students learn differently and at different speeds. Traditional education of "one size fits all" is progressively being questioned and the adoption of more progressive educations practices, which focuses and adapts to individual students has slowly been implemented. Adaptive learning and the use different training media, which gives the opportunity to practice in different manners and situations, is part of this concept.



Adaptive learning is an educational method which uses computers as interactive teaching devices, and orchestrates the allocation of human and mediated resources according to the unique needs of each learner (Wikipedia).

The potential benefits of modern and adaptive training media are:

- Involvement of the pilot in his/her own progress: instead of following a fix path where the pilot is required to learn a fix amount of knowledge in a particular order, these tools may allow them to slightly modify the amount of knowledge they will learn in the different areas and in what order.
- Possibility to adapt the learning methodology to the pilot's need.
- Possibility to adapt the learning speed to the pilot's need.
- Possibility to use different training media adapted to the pilot's need.
- Possibility to schedule training in a continues basis for whole year, instead of having 6/12 months windows. New training media and methods allow flexible training solutions that are not fix to a particular date/s of the year, instead they allow a continue training through the year.

2.4. DATA capture, feedback loop to the operator and/or Authority.

Traditional ground training provides little feedback in terms of data capture to the operator. Traditional training may only provide weather the pilot completed the training and if he/she did it successfully. Depending on the maturity of the operator further feedback loops may exists, for example pilots may inform the instructors about a particular complicated/ not well design SOP, that may then feed the operational department. New training means and method allow a more robust, consistent and data protected feedback loop that can be systematically integrated by the operator.

3. Description of new training perceptions

EBT is about the training of knowledge, skills and attitude that are related to evidence from the operation. EBT is not built from a systems point of view but from a crew performance point of view. Therefore, EBT applies competency based training principles. Once the training is implemented, evidence from training performance can be used to adapt the training program, for all trainees or for individual trainees (performance based training). Thus, evidence from the operation and from training and checking assures the desired improvement in crew performance and proficiency. Emphasis of training to the Core Competencies, particularly for the FFS training content, necessitates a broader approach to training. A variety of training media, methods and tools have to be included to support the wider adoption of competency-based programs. In this manner, crew performance can be improved and efficient use of the training resources can be maintained.

Several decades of research into a variety of training media have highlighted their efficacy in training delivery, for human as well as technical skills. By including a wider variety of training media, it is possible to enrich FFS training with competency based scenarios. Some of these media and training principles are not easy to implement in the current prescriptive regulations of training. It is therefore necessary to examine how these training media can be used to train knowledge and human and technical skills required.

Three perspectives on training that may support using these 'new' insights in a justified manner are 'informal training', 'types of learning' and 'part task practices'. These perspectives require clarification before laying out a theoretical framework that promotes providing an enhanced tooling for scenario-based, competency-based, and evidence-based training.

3.1. Formal and informal learning

Within aviation recurrent training, formal learning is often understood as prescribed training that is, in case of practical training, instructor-led and might be self-learning in case of theory training. Self-learning with regard to practical training, whether using tablets, laptops or FSTDs, is seen as informal. This is only partly consistent with Cofer's definition of formal and informal learning[20]. Cofer points out that formality relates to the control of learning objectives and goals. In a **formal learning** environment, the training department sets the goal and objectives, while in an **informal learning** setting the learner sets the goal and objectives. This definition does not consider self-learning or instructor-led learning as equivalent to informal or formal learning. Thus, formal learning, based on theoretical or practical objectives as prescribed by the organisation, can be instructor led, but may also be self-training. Similarly, informal learning, based on practical and theoretical objectives selected by the learner (and therefore also known as Self Directed Learning), can also be self-training just as well as instructor-led training.

Both formal and informal learning can be valuable, and may even be necessary in a safety sensitive organisation, to create an optimally effective and tailored training system. A potential issue with formal practical learning activities is that self-training is not commonly accepted as of yet, although the technical capabilities are enhancing and tools that are capable of registering, monitoring and coaching the activities, are readily available. Additionally, these tools can be used for informal training which enables

[20] Cofer, D. (2000). *Informal Workplace Learning*. Practice Application Brief. NO 10. U.S. Department of Education: Clearinghouse on Adult, Career, and Vocational Education.

organisations to position informal learning initiatives as optional add-ons or preparations to formal training.

A new perspective on dealing with formal and informal learning may support the usage of new media and training approaches. First, many learning environments can be 'informal' and support the formal learning process in a personalised way. E-learning (academics, serious gaming, scenarios on a tablet) can be tailored to the personal needs of the pilots. They select and organise such training themselves and the activity may be registered or even monitored by a distance instructor as necessary. Second, training media such as the FFS that are currently reserved for formal training may become more available for enriched training scenarios because lower level devices can be used for other formal training objectives and for preparation to the more complex FFS scenario training.

Possible use formal and informal training

For Formal training, the training department sets learning objectives and training is obliged. For informal training, the trainee sets the learning objectives and training is not obliged. For formal training, the training centre can allow training of certain skills and competencies via self-study using distance training devices or unlocking fixed based training devices to pilots. This self-training can be registered and performance can be monitored and coached via built- in feedback options or e-tutors. After this self-study the flight instructor is informed of the pilot performance during self-study and knows what to emphasise during integrated complex scenario training in the FFS. Additionally the pilots can make use of this suite of training tools in an informal manner whenever they think they need extra practice in order to get prepared for FFS scenario training.

3.2. Productive and reproductive learning

The selection and application of the most appropriate mix of instructional media (blended learning) should be based on learning objectives. Therefore, it is important to understand that learning objectives can be classified in different ways. In this document we use a classification[21] in which Learning objectives are classified as reproductive or productive. **Reproductive learning**, also called surface learning, is focusing on reproducing, "drilling" knowledge, procedures, or skills. The student should only apply the material learned in standard or repetitive situations. **Productive learning**, also called deep learning, is focusing on the integration of knowledge, creative appliance of knowledge, or problem solving and producing solutions based on knowledge, procedures and skills. This classification is roughly in line with the bloom's taxonomy for cognitive learning, that is widely used within aviation training, which goes from reproductive learning (remember, understand, apply) to productive leaning (analyse, evaluate, create).

With productive learning, relations between different aspects of the content are made and different approaches to problems are considered. The student can then apply the material learned in unknown and unexperienced situations. In order to acquire a competency, a blend of reproductive and productive learning elements is required and different tools can be used. Certain tools mainly support reproductive learning while other tools are better suited for productive learning.

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[21] Ebbens, S & Ettekoven, S. (2013). *Effectief leren, basisboek*. Groningen: Wolters Noordhof.

See also Colby, SA & Smith, TW (2007) – '*Teaching for deep learning*' in The Clearing House, Volume 80, Issue 5

Reproductive versus productive training

Currently FFSs are often used as reproductive trainers in which emergency procedures are practiced. This is a pity because the FFS offers the opportunity to fulfil productive training. It could be more cost-effective to use part task trainers for the training of reproductive tasks/emergency procedures. Often it is even possible to follow a (limited) whole task approach while using part-task- trainers, in which different elements of task performance and productive competencies are integrated. The FFS can then best be used for productive training to practice integrated complex line oriented scenarios. It is important that these scenarios include difficult conditions and unexpected situations in order to train productive competencies like workload management, decision-making, and situational awareness.

3.3. Part task training and whole task training

The mapping of part task training and whole task training concepts to training devices is less clear than it may at first appear. From an operational point of view, the term part task training is used for training that is performed on a part task trainer. However, from an educational point of view almost any training device can be used for either part task or whole task training, depending on the skill set that is trained[22]. **Part task training** is defined as a sequence of basic tasks that are performed separately and gradually build up to perform the whole task set (like manoeuvre training as defined in EBT). **Whole task training** focuses on the whole task from the start (initially simplified), and is only supported by part task practice when necessary or efficient[23],[24]. Part task trainers (which can be everything ranging from FSTD to 360VR, tablet simulations or serious games which can be PC or table top) can be used to provide (limited) 'whole task training'. Currently, a flight management system (FMS) trainer, for example, is designed as a part task system of operating the aircraft FMS in isolation. However, if the trainer also includes a basic cockpit simulation that allows the FMS to be operated as part of the flight environment, the task setting is enriched and programming the FMS is integrated with other crew processes. In this way a part task trainer can be used for limited whole task training. This means that there is no clear relation between part task practise and part task trainers. On the other hand, Full Flight Simulators should even be used for part task practice if high physical fidelity is required (e.g. critical flight manoeuvre training).

For recurrent training, the whole task setting is ideal for practicing productive skillsets and competencies or checking proficiencies in a realistic context, while part task practices are suitable for competencies that are rarely applied operationally or that are subject to high skill fading. Another interesting possibility of part task trainers (e.g. games), is the training of productive competencies like workload management, decision making, teamwork etc. In a later stage, transfer of the competencies to a fully realistic task setting, can be practiced or assessed in whole task trainers.

When pilots get enough opportunity to practice in responding to a wide range of abnormal events, by using alternative training devices and methods, they will be able to transfer these skills to situations that have been never encountered before. So even when it is

[22] Field, J. & Van der Pal, J. (2009) Part-Task Training in ATC; A review of opportunities and risks. NLR-TP-2008-834

[23] Van Merriënboer, J.J.G. & Kirschner, P.A. (2007). Ten Steps to Complex Learning. Mahwah, NJ: Lawrence Erlbaum Associates.

[24] Van der Pal, J. & Abma, H.J. (2009). Competencybased pilot training for the Royal Netherlands Air Force. Proceedings ITEC 2009, Brussels.

impossible to practice and integrate all abnormal events in FFS scenarios the pilot's resilience increases by using alternative training (part task, self-training, informal, etc). This resolves the flexibility problem as identified in current training.

Example of when to use whole task trainers and part task trainers

When implementing EBT there are two phases of training requirements for recurrent training. Manoeuvres and scenarios that incorporate competencies coming out of the EBT analysis, and system malfunctions as defined by regulation. An example of how to deal with this binary approach is:

1) to ensure that the regulation based malfunction training is practiced on part task trainers where possible,
2) that the EBT required manoeuvre training is practiced in FNTPs or, if necessary, in an FFS, and
3) that the integration of these skills and competencies is practiced and assessed through integrated complex line scenario training in the FFS.

3.4. Ensuring effective learning

From an educational design point of view, many training means can and should often be used to achieve the training objectives. In order to maximize the effectiveness of the training program, a structured approach that defines the mix of different training media and principles is required. The following approach helps to select different training methods (formal/informal, self-training/instructor-led, practice/theory) and different training devices (part-task/whole-task) in order to compose the training.

Blended learning and its principles

Blended learning consists of a systematic process of selecting and applying the most appropriate mix of instructional media in which knowledge is integrated with skills and is not completely separated into 'ground school'. Educational methods advocate matching media to the instructional events (e.g. reading a book, an assignment, a scenario) that are constructed to provide learning experiences that relate to the selected learning objectives (Sugrue and Clark, 2000; Van Merriënboer, 2007)

Blending and sequencing theory & practice

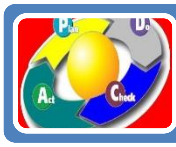
The Four Components/Instructional Design model (4C/ID)[25] offers a structure to design a blend of instructional events and tools in which theory and practice are well attuned. The model includes four components, as specified in the adjoining table 1 below.

For initial training, or training new tasks during recurrent training, the **learning tasks** are whole tasks, ordered in a structured manner, for example from easy to difficult. The complexity of the task depends on the number of operational conditions that are integrated in the scenario (e.g. weather, malfunctions, time pressure). Along the different scenarios **supportive information**, **Just-In-Time (JIT) information** is provided. Whenever needed, parts of the whole tasks can be selected and offered

[25] Van Merriënboer, J.J.G. & Kirschner, P.A. (2007). Ten Steps to Complex Learning. Mahwah, NJ: Lawrence Erlbaum Associates.

separated from the whole task in order to automate the skill. This is called **part task practice** and is provided whenever necessary, as much and as long as needed.

Table 1: 4C/ID model



Learning Tasks
Concrete, authentic, whole task experiences that are provided to learners in order to promote schema construction for non-recurrent aspects .

Supportive Information — information that is supportive to the learning and performance of non-recurrent aspects of learning tasks. Supportive information consists of mental models, cognitive strategies and cognitive feedback.

JIT Information — information that is prerequisite to the learning and performance of recurrent aspects of learning tasks, like emergency checklists and weather information.

Part Task Practice — critical recurrent skill practice provided to learners to promote automation for selected recurrent aspects of the whole complex skill.

For recurrent training, the 4C/ID principles can be used to practice more complex (unexpected) situations with varying operational conditions by means of part task trainers. In order to get the most benefit out of FFS sessions and increase agility, part task trainers can be applied in advance of the LOFT scenarios. In the process of part task training and limited whole task training, supportive information is offered to enhance understanding and integration in support of whole task performance (e.g. providing the reasoning of a procedure via a briefing or e-learning, prior to practicing it on the part task trainer).

Blending and sequencing Part task & Whole task practice

Traditionally, instructional design models use either part task or whole task practice, but the 4C/ID model advocates a combination of both. The sequence of learning tasks (whole tasks) is the backbone of training, while part task practice supports learning or refreshing the highly routinized skill set at the time where it is needed most in the sequence of learning tasks. In other words, the part task practice automates specific skills or competencies that are part of the whole task training outside the whole task training exercise.

Blending individual and cooperative learning

Cooperative learning refers to learning activities in which learners engage in a common learning task where each individual depends on and is accountable to each other; where the authentic task depends on more than one individual, cooperative learning needs to take place. However, supportive information and part task practice that is supportive to whole task performance can be learned individually or cooperative, depending on 1) the situation, e.g. learners' preferences, possible resources and monitoring needs and 2) the possibility of downloading/ integrating the learned into the whole task performance in the authentic, cooperative context. Cooperative learning activities can include real time or simulated practice, joined problem solving. The result depends on the weight of each of the participant.

Applying the blended approach according to 4C/ID

If the result of an EBT analysis is that pilots have a problem with executing go-arounds, then according to the 4C/ID principle a short module built up from medium to difficult landing situations would be set up, applying training media with varying fidelity levels. For example, the first go-around scenario can be relatively easy requiring a go-around at the decision altitude with both engines operational. The whole task approach here means that the pilot not only performs the procedure, but he performs the procedure under realistic but simple conditions including different aspects of the task: He needs to recognize the need for a go-around, he needs to find and use the correct procedures, he needs to communicate, he needs to cope with stress, etc. In other words, it is not just the procedural skills but also the productive competencies that are addressed (workload management, decision making, situation awareness).

In order to assist the preparation for the recurrent training session, supporting information on go-arounds (academics and potentially including information from the EBT analysis) can be provided to the pilots, e.g. in text, an e-learning, or through virtual reality (VR). During the training sessions, just-in-time information and feedback may be necessary and can be provided (handouts, automatic feedback, instructor support). In one training session, the scenario can be repeated under different conditions, but approximately similar difficulty level. Once the difficulty level is mastered (no failures) on for example VR, the pilot performs the task again but under more complex conditions. A next training session, the highest difficulty level is trained under varying conditions using a more advanced training tool and guided by an instructor. When this difficulty level is mastered (no failures; no support from the instructor), the final training session may be combined with e.g., a regular LOFT training in which a go-around procedure is required but not announced. Thus, the task should be trained several times with different levels of complexity, until transfer in a realistic (unexpected) setting is demonstrated.

In the situation described above, the 4C/ID model is applied comprehensively to fix an established performance deficiency. In addition to already planned LOFT training, this may require no more than two hours of individual self-training and one-hour instructor led sim training. Normal recurrent training of course is primarily to refresh skills already mastered and is provided before proficiency deficiencies occur. For regular refresher training 4C/ID's benefit is in experiencing different situations. Once the pilot has practiced the skills in different situations on lower level devices (but partial task, e.g., single pilot instead of crew training), they are transferable towards other, more complex situations. This means for example that not all malfunctions need to be trained in the FFS. They can be trained in lower fidelity devices given a variety of working conditions. Some of the malfunctions can be injected in FSS LOFT scenarios, unexpectedly of course. The idea is that by applying some of the skills and competencies in the LOFT scenarios, the pilot becomes resilient and can also apply the other trained skills in real life.

4. Fidelity of training media

The authenticity, or the so-called fidelity, of training has an influences on the transfer of training to the work environment. Practical learning experiences can have a variety of attributes that either support or harm training. For example, an experience can have:

- Physical authenticity: the extent to which the practice task mirrors the physical context and processes of the real task. This is enabled by the **physical fidelity** of training devices.
- Cognitive authenticity: the extent to which learners are required to engage in the cognitive processes employed by expert performers. This is enabled by the **functional fidelity** of training devices.

Studies of the fidelity required for training often reveal that a lower physical fidelity device is sufficient for the training goal. For most training high functional fidelity is required, because the performance of the cognitive steps that belong to a task need to mirror the competence that needs to be learned. If the cognitive steps are well understood and mastered, this competence can be transferred to an environment with a different physical authenticity (e.g. when the pilot gets different situations on how to recognize and handle an A330 engine fire on a lower level device, he can transfer this competence to the real A330. This is called far transfer. Thus the physical authenticity of the experience may vary as long as the functional (cognitive) authenticity is high[26].

In contrast, when the focus of the training is on (automation of) psychomotor skills, the physical authenticity is of critical importance in addition to functional authenticity. This only supports near transfer[27] (e.g. when the objective is to experience how the yoke of the B787 reacts in certain situations, this should be taught in a high fidelity B787 simulator). Low-fidelity devices obviously may induce negative transfer for certain skills, but examples of negative transfer from high fidelity devices are also possible. The risk of negative transfer may even be larger for high physical fidelity devices due to a potentially misplaced confidence in high fidelity simulators. Low fidelity simulation is not expected to be realistic and this may, counter-intuitively, reduce the risk of negative learning. This statement is supported by the National Transport Safety Board accident report of November 2001 (American Airlines) finding number 18 indicates that: 'The use of lower levels of automation such as simulators without motion or simple computer screen displays, may be more appropriate to provide the necessary awareness training with less danger of introducing incorrect information'. However, some occasional accidents also demonstrated that high physical fidelity is required to ensure no negative training is achieved when automating skills.

Note that it is not he overall fidelity level of the simulator that matters but selective fidelity, which should be determined based on training objectives, costs to achieve the objectives, and the contribution to the operational competences[28]. From low fidelity simulators it is assumed that they are suitable for development of certain skills like problem solving. Low fidelity simulation can, for example, be readily used to share knowledge, define and follow plans and distribute work, as a part of a larger training module, in order to save time and as preparation or addition to training with high fidelity simulation[29].

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[26] Clark, R. E., & Sugrue, B. (2000). Media selection for training. APA handbook on training. Washington, DC: American Psychological Association.

[27] Toups, Kerne, Hamilton, & Shazad, 2011

[28] Foster, R. E., & Fletcher, J. D. (2013). Toward training transformation. Military Psychology, 25(3), 308–317.

[29] Dahlstrom, N., Dekker, S., Winsen, R. van, & Nyce, J. (2009). Fidelity and validity of simulator training. *Theoretical Issues in Ergonomics Science*, *10*(4), 305–314.

It is important to understand that high fidelity training media does not automatically ensure high quality training. Training media are a tool to support the training; their efficacy depends on the way that the media are applied (e.g. quality of the instructor, training design, instructional feedback). Therefore, the selection of training media cannot be seen as an isolated process.

5. New technologies

A number of new technologies are emerging in the field of educational and corporate learning. These technologies are looking to enhance existing training programmes and improving the quality of the program, participation and engagement as well as making the training a more personalised experience.

Examples of some of these technologies:

Mobile learning:

When it comes to delivering training content, mobile devices such as smart phones and tablets are todays target platform. They are highly mobile enabling learning taking place without the need for a fixed time or place and support a greater range of learning styles through the use of animations, videos and 3D models combined with a testing platform. Appeals to the millennium generation as learning platform.

Avatars

Studies[30] [31]have shown that the use of Avatars has the benefit of better learner engagement. E-learning content can make use of interactive avatars to emphasise particular learning points, and can offer a "human" touch and a way to deliver a consistent instructional message. A number of modern military instructional training systems have employed avatars and proven their effectiveness in enhancing e-learning content.

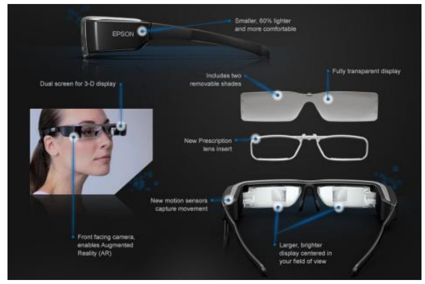
[30] https://shar.es/1O1LDY

[31] https://vhil.stanford.edu/topics/avatars-agents/

EARLY DRAFT FOR THE EBT WORKSHOP.

THIS DOCUMENT IS NOT THE FINAL CONCEPT PAPER. PROOF READING NOT PERFORMED.

Virtual and Augmented Reality:



Virtual Reality is a technology that has become very accessible in the recent years with the hardware costs now coming down to an affordable level. The technology creates virtual environment for the wearer of the headset, and with external sensors can sense the position of the individual in the virtual world. Additional feedback to the user can be provided with the additional haptic feedback gloves. This technology focuses on the immersion of the individual and is powerful training tool when it used with the training objectives clearly defined.

A more passive form of training can be achieved, with 360-degree training videos played through VR headsets. The hardware costs can be greatly reduced by using mobile phones mounted in a headset, making the technology accessible to the distance learner. By integrating such video's into training courseware they can become interactive.

Augmented Reality offers the ability to blend the virtual world with the real world and allow interactive and enhanced training in individual and a multi crew environments. The user can now see their environment and interact with in a multi crew-training environment (means of avatar).

Adaptive Learning & Data Analytics:

Adaptive learning delivers personalised training, through the monitoring of current performance, the training journey is modified in a non-linear fashion to deliver maximum training effectiveness. Using data analytics the adaptation engine is able to make the decisions required to deliver optimal training. Adaptive learning technology can be applied to e-learning content, but has the power to be extended to all training tools. Data analytics provide the evidence that training is taking place, and can be used to assess not only trainee performance, but that of the instructor and the quality of the training course. As with any system based on data, the system's performance improves with the increasing throughput of data.

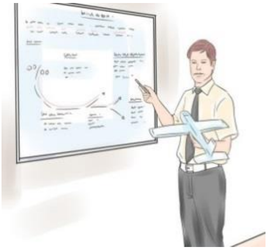
6. Examples of training tools to support blended learning

This chapter describes different types of training tools and their training characteristics. That means that per training tool/media it is indicated for which kind of training characteristics the tool is suitable, like formal, informal, part task, whole task, fixed location, mobile location, see table for definitions of training characteristics. New technologies as described in chapter five can be integrated in the training tools or can be stand-alone techniques. E.g.an Flat Panel Trainer can be used as a stand-alone or can be augmented with virtual buttons via a AR glasses. Additionally, the FPT training can be personalised in an automated way, through the monitoring of current performance, by means of adaptive training technologies. Another example is that serious games can be built in VR or can make use of avatars that are projected in the room by means of AR.

Table 2: Definitions of training characteristic

Training Characteristics	Definition
Formal	Training in which the regulator or the ATO prescribes the goals and objectives of the training
Informal	Training in which the individual pilot sets the goals and objectives of the training
Person guided	Training in which information, support and feedback is provided/coached by an instructor
Non person Guided	Training in which information, support and feedback is provided by a computer or a virtual instructor
Reproductive	Training in which the pilot needs to reproduce knowledge or apply procedures in a highly standardised way and under standard circumstances; these knowledge or skills do not require problem solving; they can be routinized ("drilled")
Productive	Training in which the pilots needs to produce a solution to a non-standard problem. This may require complex knowledge or creative problem solving.
Adaptive	Adaptive training is an personal training approach that uses learning analytics throughout the training to provide personalised guidance and support, feedback, and selection of tasks.
Functional fidelity (device/emulation/sim)	The extent to which a pilot can perform tasks in the same way in a training device as in the real aircraft and context. In other words, the extent to which cognitive steps the learners have to take, mirror the competencies that have be learned.
physical fidelity (device/emulation/simulation)	The extent to which a training device matches the real aircraft and context. In other words, the extent to which the simulation mirrors the physical environment and processes of the real system.
Information fidelity	Level in which the information that is used equals the real system / pilot information
Individual	Training tasks that requires actions from a single pilot
Cooperative crew	Training tasks that requires actions from a crew (real pilots) or training in which pilots need to collaborate to learn
Cooperative virtual	Training tasks that require actions from a pilot and a virtual crewmember
Mobile	Training that can be delivered at anytime and anywhere.
Fixed location	Training that is delivered at a fixed location.
Synchronous	Training in which collaboration or coaching is provided simultaneously (in real time)
A-synchronous	Training in which collaboration or coaching is provided not simultaneously

Table 3: Training tools/ media

Objective type (focus)		Type of training media	Characteristics of training media (in general)	Best practices and examples
Reproductive academics		Information providers (lectures, books, manuals, e-materials (e.g., page turner CBT))	Formal Informal Person guided Non person Guided Reproductive Adaptive Individual Mobile	• Theory training on different topics (technical and operational knowledge).
		Interactive teaching (instructor lead discussion, case studies)	Formal Person guided Reproductive Adaptive Cooperative crew Fixed location Synchronous	• Real time situations from various airlines: events in which participants discuss how to respond to it. Outcomes can also be used to adapt company procedures • CRM cases (with flight attendants) events in which the participants discuss how to respond to it
		Interactive digital or face-to-face knowledge sharing (best practices, lessons learned from incidents, discussions using SharePoint/networks	Formal Informal Person guided Reproductive Adaptive Cooperative crew Fixed location Synchronous	

Objective type (focus)		Type of training media	Characteristics of training media (in general)	Best practices and examples
		Interactive (mobile) eLearning	Formal Informal Non person Guided Reproductive Adaptive Individual Cooperative crew Cooperative virtual Mobile Fixed location Synchronous A-synchronous	
Reproductive & productive practical (cognitive, affective, psychomotor)		Game based learning and gamification (PC or table top based)	Formal Informal Non person Guided Reproductive Productive Adaptive Functional fidelity: high physical fidelity: low Information fidelity: low to high Individual Cooperative crew Cooperative virtual Mobile Fixed location Synchronous A-synchronous	
		PC or tablet simulation	Formal Informal Non person Guided Reproductive Productive Adaptive Functional fidelity: High physical fidelity: Low Information fidelity: Low - High Individual Cooperative virtual Mobile Synchronous	• Tablet based drill practice tool that gives interactive scenarios which contain a problem that the pilot needs to solve. The pilot needs to: • Read engine warning / system warning displays, find panels, make decisions, use control switches (ECAM) , check the operation of the other systems by means of ECAM, use quick references guides, FCOM, MEL etc. • Decide via DODAR how to continue after the main problem is solved • Go to the webpage to reflect by means of cases, Q&A's, etc etc.

Objective type (focus)		Type of training media	Characteristics of training media (in general)	Best practices and examples
		360 VR and augmented reality	Formal Informal Non person Guided Reproductive Productive Adaptive Functional fidelity: Low-High physical fidelity: High Individual Cooperative virtual Mobile A-synchronous	• VR that provides seasonal weather patterns and changes. The trainee needs to observe and recognize visual cues/references within a 360 environment. • System reviews in look alike cockpit……
		FNPT, FTD	Formal Informal Collaborative Functional fidelity: High Physical fidelity: Medium Information fidelity: High Individual Cooperative crew Fixed location Synchronous	• FPT: Flat Panel Trainer for procedure training. Reconfigurable flat panel multi-crew training device for aircraft systems and procedures training. Trainees learn standard operating procedures in normal, abnormal and emergency conditions.
		FFS	Formal Informal Person guided Reproductive Productive Adaptive Functional fidelity: High physical fidelity: Medium to High Information fidelity Cooperative crew Fixed location Synchronous	

7. Proposed results

To achieve optimum training effectiveness and efficiency it is essential that within the instructional design of a course, a wide range of devices, including alternate training tools, Flight Simulation Training Devices and Full Flight Simulators, are considered. The course designers could then select a complementary range of the most appropriate devices to best meet the training need whilst also complying with any regulation requirement. It is further understood that, within the review stage of a mature instructional design process, the utilised range of training methods and devices are constantly evaluated for training effectiveness in the light of feedback, the current training need, educational best practices and introduction of further potential devices.

Where program design indicates that an alternate training means could be the most effective delivery method it is proposed that a characteristics matrix is produced for the training requirement of that element of the program. This process transparently enables and drives the ability of the program designer to select an alternative training means, rather than the prescriptive regulation of actual devices, which hinders the utilisation of appropriate evolving technologies. The matrix would include the required training characterises such as; formal/informal, part/whole task, reproductive/productive, adaptive, individual or co-operative (virtual or real crew), synchronous/a-synchronous, mobile or fixed and if a device is appropriate or regulated, the level of functional, physical and information fidelity. These requirement characterises would then be matched to the characteristics of training methods and devices, ensuring appropriate and transparent selection of training methods and devices and the potential ability to utilise appropriate developing technologies.

The initial approval of the above processes then enables effective performance based oversight, whilst requiring the operator or ATO to constantly review and update their course(s) based on feedback and data, to reflect current educational best practices and to consider appropriate technology advances

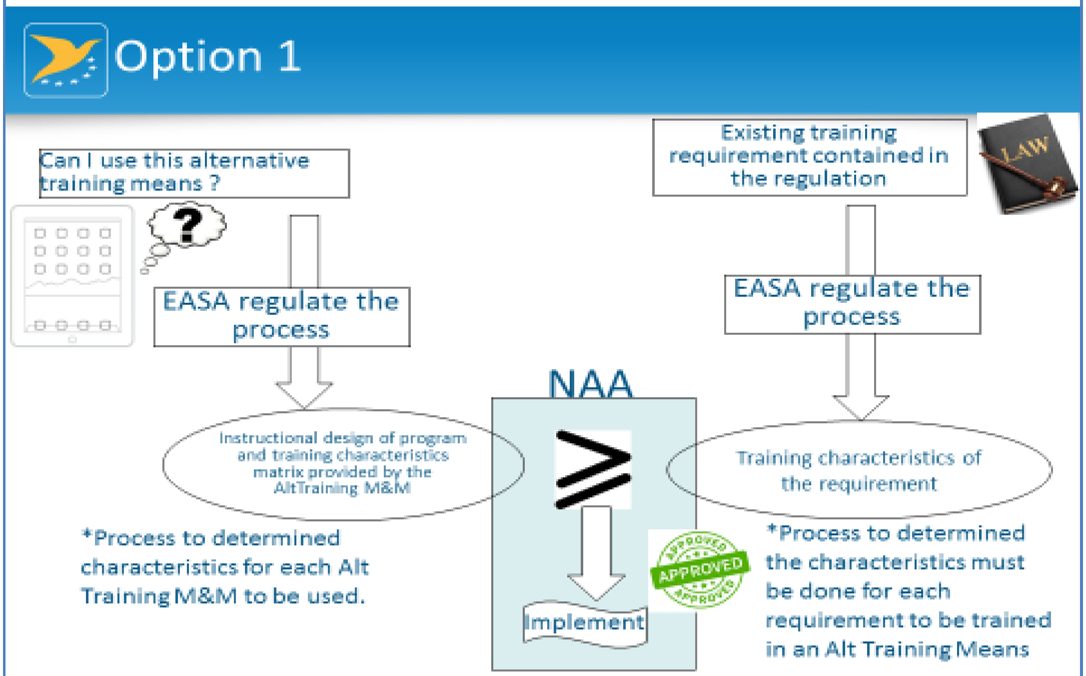
8. Identification of the possible options

For the identification of the possible options, the rulemaking foresee a pre-requisite for all options to implement Alternative training means and methods:

the requirement of the operator or ATO to create processes that include:

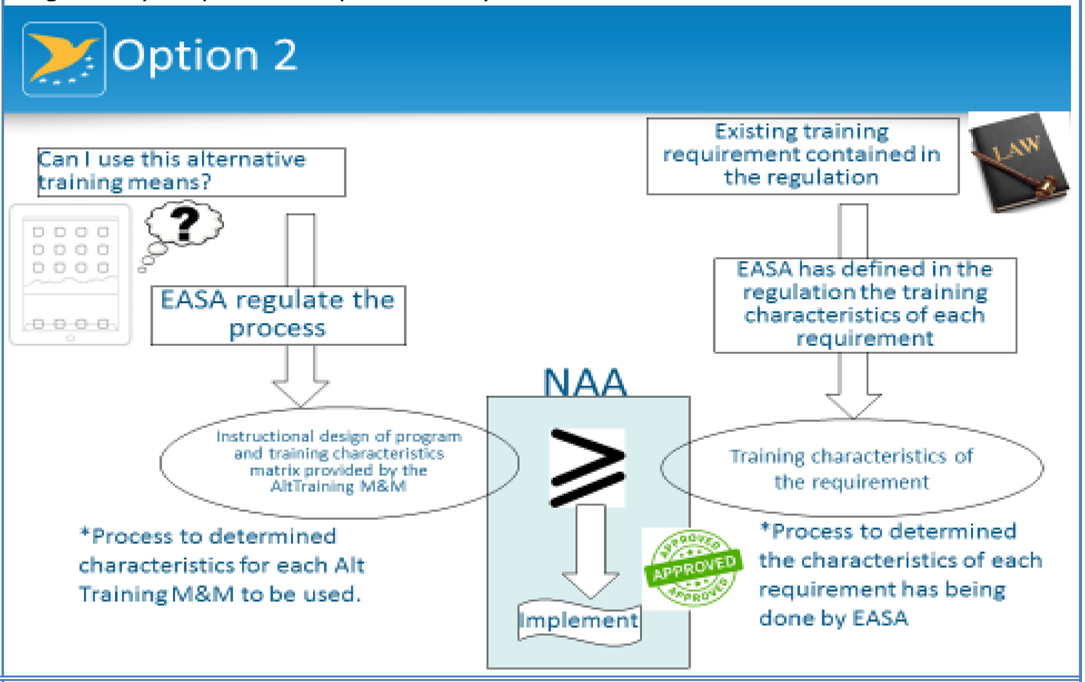
a) instructional systems design to create the training program, and
b) training characteristics matrix for each element that could benefit from alternate training means. This training characteristics matrix maps the required training characteristics to direct and drive the selection of the most appropriate training methods and devices, which enable alternative training means, and complies with regulatory requirement

Table 4: Possible options

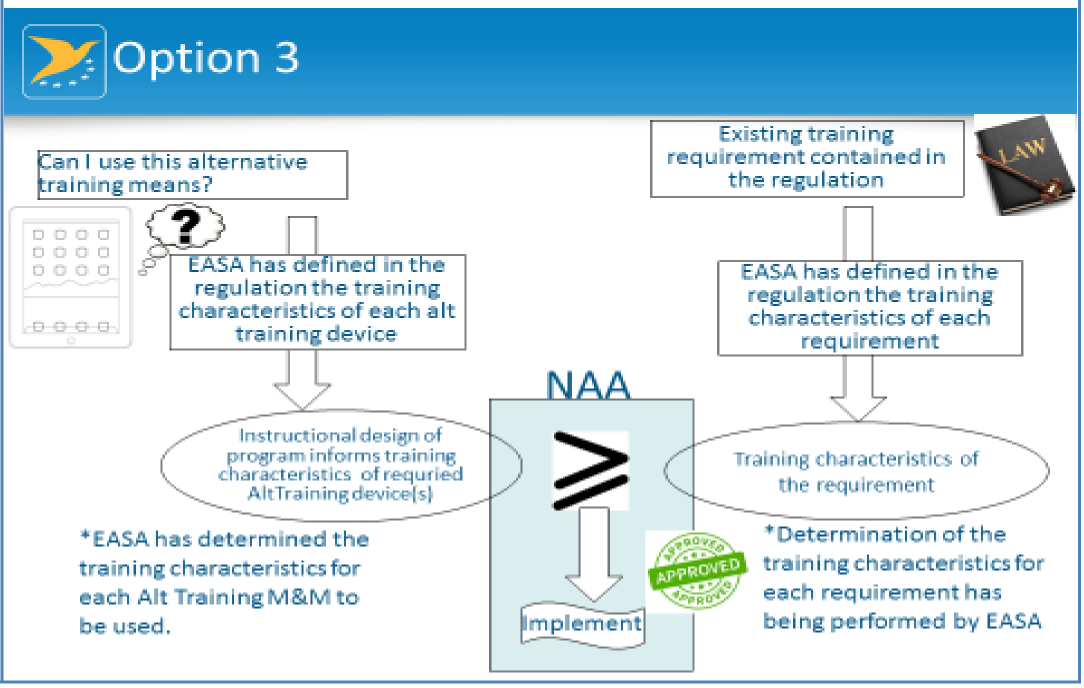
Option	Description
0	Do nothing
1	Develop a regulation that allows the use of new alternative training means and methods where: EASA provides: - the process to identify the characteristics of each regulatory requirement, and - the process to identify the characteristics of each alternative training means the operator/ATO defines based on the process provided by EASA: - the regulatory training characteristics, and - the suitable alternative training means which fits in each element of their training program, (note: see description in (b). It is based on the training characteristics of each alternative training means and the instructional training design to create the training program) the competent authority approves the work performed by the operator described above 
2	Develop a regulation that enables the use of new alternative training means and methods, where: EASA provides

- each training characteristics of each regulatory requirement, instead of providing just the general process, and
- the process to map the characteristics of any alternative training means (Note: same as Option 1 see more details above)

the operator/ATO will apply the process to the training mean/s that fits its instructional training system design and get the approval form their competent authority. The operator will use the alternative training means in those regulatory requirement that match the training characteristics of the regulatory requirement provided by EASA.



3 Develop a regulation that allows the use of new alternative training means and methods, where EASA provides the training characteristics of each regulatory requirement and where EASA provides the training characteristics of each alternative training device. The Authority approves the use.



9. Analysis of impacts for the possible options

WORK IN PROGRESS. Drafting after the EBT WORKSHOP.

Drafting principles for this chapter:

[The analysis should identify major impacts resulting from implementing the considered possible options on all affected sectors. The below chapters can be combined or omitted if a certain category of impact is not expected for any of the options.

The analysis should identify the sectors of the civil aviation community (including authorities and the Agency) within the regulated domain. These sectors include manufacturers, operators, maintenance organisations and staff, crew, training organisations, aircraft owners, etc. If a specific category of persons, small businesses, and regional groups are likely to be differently affected, this shall be identified for further evaluation and quantification. Only those sectors that are directly affected by the intended measure need to be considered.

- One should pay particular attention to the following parameters:
- Specify which impacts are likely to change over the time and how.
- Use the baseline situation described above as a reference: How can each possible option contribute to improving the baseline situation and to what extent? How can the risks identified be mitigated by each key option?
- What are the potential obstacles to improve the baseline situation?]

9.1. Safety impact *[if relevant]*

The requirement for instructional design processes will have a positive impact on safety due to the requirement of the operator to continuously review external data including accidents and incidents, LOSA reports and FDM data in addition to internal feedback to update and improve the course. The use of the characteristics matrix rather than static regulated devices should enable more effective and efficient courses design which should result in an improved output standard of the pilots KSA.

9.2. Social impact *[if relevant]*

[Social impacts may include: Impacts on employment and on labour market, working hours and working conditions, free movement of personnel, health, social inclusion and protection of particular social groups, gender equality, equal treatment and equal opportunities, non-discrimination, access to social protection.]

9.3. Economic impact *[if relevant]*

[Economic impacts may include:

- compliance costs/savings for the industry, licence holders, staffing, or consumers;
- increased administrative burden or simplification of the administrative process;
- cost stemming from non-uniformity of rules at EU level;
- implementation costs (transitional period with additional cost impacts)/savings for NAAs; and
- competitive disadvantages or advantages.]

9.4. Proportionality issues *[if relevant]*

[Proportionality issues may include:

- impacts on small and medium enterprises;
- impacts on General Aviation;
- impacts in terms of regional/sectorial distribution: Is a region/sector particularly negatively affected by the proposals?]

9.5. Impact on regulatory coordination and harmonisation *[if relevant]*

[Issues to be considered include, for example:

- Are there any implementation problems expected for the possible options?
- Is any other EU legislation affected?
- Is there a possible option where national action is considered instead of EASA rulemaking? Is the issue under Community competence?
- Is there a danger of duplication at national level?
- Does a possible option have an impact on Member States' obligations towards ICAO?
- Do the possible options harmonise the requirements with Third Country (e.g. FAA, TCCA) requirements?
- Do the possible options harmonise the requirements with ICAO?
- Are there any potential obstacles and incentives to compliance?]

9.6. Impact on existing organisations including the Agency *[if relevant]*

[Describe the long term impacts on the Agency or any other existing organisation as NAAs, DOAs, POAs, Operators, etc. by assessing the benefits and impacts of the key options. Long term impacts include impacts on existing management system, procedures, liabilities, financial and human resources, interfaces, etc.]

10. Regulatory road map

The regulatory road map proposed by the Agency started with the celebration of a workshop of alternative training means celebrated in Cologne the 19 and 20 October 2016. For that purposed Project management RMT0599 invited several training researches, software specialist and aviation experts.

Furthermore, on the 1 February 2017 the concept paper was again presented, this time to a broader audience (approximately 210 people participated) in the 1st Workshop on the Implementation of the Evidence-based Training (01.02.2017 Cologne).

Step 1

Establish a process whereby the alternative training device characteristics can be identify, the table should provide at least the following information:

- Training focus (objective) (eg Cognitive, etc)
- Training media characteristics:
  - Reproductive/productive
  - Part task/ whole task
  - Instructors lead/self training
  - Practical/ theory
  - Individual/ collaborative
  - Fidelity of training:
    - cognitive fidelity,
    - physical authenticity,
    - Information fidelity,
    - Accelerations fidelity
- Type of training media (eg. IPAD, Virtual reality etc.).
- Minimum hardware or software characteritics :
  - Hardware requirements
  - Software requirements
  - When there is the need of an integration of the hardware requirements and software requirements
- Limitations
- Recommendations
- Best practices and examples
- Others

Step 2

In the initial steps of the regulatory process, the scope will be limited to Commercial Air transport training requirements. Therefore, the step 2 will be as follows:

Extract from the European regulatory system all training requirements that may subject to the use of alternative training means. The list of training requirements should include as a minimum a review of the Regulation (EU) 965/2012 'the air Ops regulation', Regulation (EU) 1178/2011 and any other relevant European regulation such us Regulation (EU) 748/2012 Part-21.

The list should provide the following information:

- Title of each training requirement
- Short description
- Short reference to the rule
- Training requirement characteristic, some of this characteristics may be:
  - Weather it must be Instructor lead/ or could be self-training
  - If is a practical training/ or theory

    - Weather it required to be collaborative (eg. sim in multicrew) or maybe individual
- The minimum fidelity of the training device
- Any limitation the training requirement
- Recommendation
- Best practices (if any) in the industry
- Other

Step 3

The rulemaking group RMT0599 when possible will match each training requirement with each type of training media based on the training need of each requirement (step 2), following the limitations, characteristics, recommendations etc of each type of training media developed in step 1.

Please note that the Agency may decide to use a progressive approach therefore the Rulemaking group may work following the resulting process stablish in EBT

- **Phase 1**: subpart ORO.FC.: ORO.FC.230 recurrent training and checking, and Part SPA, supart LVO.
- **Phase 2** supart ORO.FC: ORO.FC.205 command course, ORO.FC,220 Operator conversion course and initial type training in regulation 1178/2011, etc.
- **Phase 3** enlarge EBT to other type of aircrafts and helicopters

11. Conclusion

WORK IN PROGRESS. Drafting after the EBT WORKSHOP.

12. Appreciation, acknowledgements

Principal author National Aerospace Centre represented by Anneke Nabben

Contributors:

Yann Renier (Chair of RM Group 0599 – IATA), Jelke van der Pal (NLR), Jacqui Suren (CTC aviation an L3 company), David Lord (FSI), Andrew Mitchell (Use Before Flight), and James Evans (bluespot.io)

EASA Project management RMT0599 Francisco Arenas Alvariño.

13. Annex 1 - Proposed Technology Guidelines

Due to the requirements under Alternative Training Means for a reliance on new technologies and computer based solutions (both software and hardware) the rulemaking envisage that any future regulatory material should be heavily supported with non-regulatory material related to software, hardware and other computer based technology information. This is an illustration of how the future supporting material could be formatted to aid airlines and ATOs to help with selection of technology under the proposed process of Alternative Training Means.

The Rulemaking group may require tech industry experts to provide the latest best-practice advice and possibilities from the tech sector.

GUIDANCE FOR SELECTING SOFTWARE SOLUTIONS			
No.	**Title**	**Description**	**Best practice - what to consider**
1	Hosting	Understanding where the software you are using, is being hosted	• In-house - Is the server in your building? - High level of control and server is in your actual building. Very high set-up costs, dedicated personnel to administer the servers. Costly to scale and requires large scale development to justify the financial and management outlay. No reliance on 3rd parties • Remote owned server - similar to In-house server, however a 3rd party looks after some maintenance and the server is dedicated to your use only. You are however, still responsible for many areas of server management including any security patches. You physically own the server therefore replacement and update are your responsibility. Scaling can be time consuming and expensive. The overall cost will be less than in-house, but far more than a rented option. Some reliance on 3rd parties • Remote rented server - Server can be dedicated or shared with others (depending on cost) and you will have more reliance on the hosting company providing the service they offer. Advantages are that scaling is fast, flexible and inexpensive (paying for what you use). Setup is very straightforward and geared up to agile development with little commitment. Servers are upgraded for both software and hardware as part of the cost. Security patches are included without your input. This set-up is what most people would commonly refer to as ‘The Cloud’. High reliance on 3rd parties

2	Open standards, common platforms and interoperability	The software supplier's choice of coding standards and platform targeting is one of the most critical aspects to get right. A bad choice of software standard and device compatibility will give a lack of flexibility when needing to upgrade or change to new hardware providers. Airlines that make poor choices will end up being locked into contracts with antiquated technology. Software requiring 3rd party plugins should be risk assessed; popular browser are now progressively limiting the use of plugins and moving to native web technologies. It also puts a reliance on a proprietary technology you may not have control over.	To consider • Is the Software built using open standards? • Can software run on all current and potential future platforms? (eg. Windows, Mac, iPad, iPhone, Android etc)? See "4. Device Agnostic" • If software has a dependancy on 3rd party plugins has a risk assessment been completed? • Software uses APIs to connect to other current or future services that may need to cross-communicate and share data. In other words is the software able to communicate with other existing systems of your organisation? *An API ("Application Programming Interface" is a set of defined functions and methods for interfacing with the underlying operating system or another program or service running on the computer/device.*)
3	Software installation method	There are two main methods for software installation: - Software as a Service is a software licensing and delivery method which software is licensed on a subscription basis and is centrally hosted in the 'cloud'. Cyber security, updates, upgrades and new features driven by client feedback tend to be included in the subscription costs - Bespoke on-premises software is where the software is installed and runs on computers on the premises of the organisation using the software rather than a remote facility. Software can be developed and installed in one or other method, or a blending of both and care should be taken to ensure the best option is chosen to limit risk to the project, including unforeseen future changes in the regulatory or market environments.	• See *flow chart: SaaS solution v Bespoke solution*
4	Device agnostic	The software you plan to implement is not tied to any one specific device, mobile or otherwise.	• How will the software be used • Do you expect user to use various different devices, mobile, desktop, brand specific, iOS, Android, other • Will you be supplying this device and controlling usage or will user engage with their own personal device
5	Agile development	Agile development is an umbrella term for different methods and frameworks of building software.	• You should expect to be heavily involved (anywhere from every day to at least once a week). The provider should expect and insist on this involvement.

		After the classic 'decide more upfront and plan rigidly' approach to managing software projects (the waterfall approach) had been shown consistently to fail, agile methods, which are much more adaptive and collaborative, are these days considered best practice for the complexity of most modern software development.	• Work should be split into distinct chunks, which should be user facing (something a potential user of your product can see). Even as a layman you should easily understand what getting each finished changes or adds to your product. • You should be expected to make decisions on priority, and to be able to prioritise effectively (every feature cannot be priority No.1, start small and build on it). • There should be some degree of uncertainty on delivery (this is a *good* sign), the truth of complex work is that anyone who appears certain is willing to cut quality in the crunch, or is padding the estimate at your potential expense • You should be seeing features you can personally use and test (at least) every iteration (one week, two weeks). The more often the better
6	Offline functionality (if applicable)	Assess the requirement for offline functionality due to the nature of pilots' work environment. Consider requirements of offline and weigh up the added complexity and cost of a hybrid offline/online solution.	• If needed, the software has an offline mode for critical functionality • The system has back-ups in place for any data corruption or server downtime
7	Security and data protection plan	Due to the international nature of the airline industry, data protection rules are critical to understand and will vary in each of an airline's relevant jurisdictions. This can include the physical location of servers and the way that personal data is stored. Certain jurisdictions have strict rules on how long identifiable data can be stored for and any software solution containing this type of data will need to have considered this.	• The software provider is aware of the exact data protection rules for each relevant jurisdiction for your airline and can confirm geo-location of their data • Geo-location of servers is compatible with data protection rules • The software encrypt all data flowing to and from the application (e.g. HTTPS; Hyper Text Transfer Protocol Secure) • The provider has experience of deploying cloud-based software using secure corporative systems (e.g. SAML/LDAP) to allow clients to control user login centrally from their internal systems
8	Industry experience	Engaging with suppliers that have experience of implementing or creating software solutions for data intensive programmes will lower overall risk.	• The provider has previous experience of implementing software for data intensive programmes

Flowchart: SaaS solution v Bespoke solution