HOW LEVEL 2 FLIGHT TRAINING DEVICES CHANGE THE FUTURE OF PILOT TRAINING

Or: "Perfect is the enemy of good." A Lufthansa Aviation Training Whitepaper Based on an Expert Online Panel Discussion in September 2021.

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1. CASE STUDY: INTRODUCING LEVEL 2 FTDS AT AUSTRIAN AIRLINES

1.1 Introducing FTDs into an FFS-driven training environment

In December 2020, an A320 Flight Training Device (FTD) Level 2 was certified and put into operation at the Lufthansa Aviation Training Center (LATC) in Vienna (Austria). Since then, LAT has been able to gain valuable insights into practical training situations with its customer Austrian Airlines. Interestingly, this device was originally planned for phase 3 multi-crew pilot license (MPL) training at LAT's flight school in Munich (Germany). Due to a drop in demand for *ab-initio* training caused by the pandemic, Austrian Airlines expressed great interest in using this device to enhance their A320 training.

As a matter of fact, this device is the second A320 Level 2 FTD within LAT's fleet of flight simulation training devices (FSTD). The first A320 Level 2 FTD was installed in Zurich in close cooperation with L3Harris in the summer of 2020. What makes the Vienna case interesting is that this is the first FTD that was incorporated into regular recurrent training of one of LAT's major airline customers. In contrast, LAT originally expected these devices being used primarily for type ratings or *ab-initio* trainings.

The applicability for a broad range of training purposes was also possible due to LAT's technical specifications, which aim at meeting the highest non-motion standards applicable under the upcoming CS-FSTD Issue 3[1]. This new regulation has been in preparation at the level of the European Union Aviation Safety Agency (EASA) for several years already and is scheduled to take effect by the end of 2023. This new version will introduce a more standardized concept, based on International Civil Aviation Organization (ICAO) document 9625, with the aim of aligning training tasks with actual FSTD capabilities. This STD capability signature (FCS) assigns one out of four fidelity levels to each of the twelve system areas of an FSTD. From the beginning, LAT aimed at reaching full-flight simulator (FFS) Level D capabilities in the majority of the twelve system areas.

LAT expects that, with the decision to aim for the highest fidelity level possible on a non-motion FSTD, over 80% of all training tasks of a typical type rating could be conducted on its new A320 Level 2 FTD.

[1] Certification Specification – FSTD. Please note: EASA plans to unify the respective CS-FSTDs for Airplanes (A) and Helicopters (H) in the future. Therefore, the nomenclature is subject to change.

1.2 Experiencing Level 2 FTD – the First Year

Austrian Airlines first introduced its training program on the A320 Level 2 FTD at the beginning of 2021. By November 2021, they had completed over two thousand hours of training on this device, with the training ranging from type-rating sessions and non-license-relevant re-qualifications to refresher sessions as part of the recurrent training. Based on this broad experience of the pilot corps, Josef Fischer, chief training captain A320 at Austrian Airlines, summarizes in an introduction video for the panel discussion as follows:

"As soon as the aircraft is in the air, the landing gear is up – it absolutely feels like being in a normal full-flight simulator. [...] As chief training captain I was asking myself to which extent we can incorporate the FTD in our training because it is not moving. And that was also the first experience that I had. Colleagues were manoeuvring the aircraft on the ground and that wasn't ok, that felt completely strange, because there was nothing moving. But finally, when we got up in the air, we were flying like on an aircraft or on a full-flight simulator and at the end of the session they even stowed their loose items in the cockpit to protect them."

Especially the latter highlights the importance of a high-fidelity collimated visual system. Together with the fully enclosed and replicated cockpit environment, this creates a strong sense of immersion for the pilots. Therefore, as soon as the aircraft is airborne, the pilots barely feel a difference in their FFS experience. This fact was also supported by the following statement of Alexander Tschuggmall, assistant to the chief flight instructor A320 at Austrian Airlines:

"We surprisingly found out that the FTD is also very suitable for manual flying skills as soon as the aircraft is in the air. [...] We have conducted a complete round of recurrent training with several hundred pilots. As a pilot and developer of pilot programs I can assure you that most competencies can be trained very well. The only exception is manual flying on the ground – as far as taxiing, take-off and landing, it is unrealistic."

During the panel it was also highlighted that there are differences within the group of pilots due to their different levels of flying experience, meaning that more experienced pilots might be suitable for a higher number of non-motion FSTD training due to their extensive flight-hour experience in the real aircraft. Therefore, motion effects are already anchored to a much larger extent than they are for newly appointed pilots.

An interesting debate unfolded during the panel discussion between Andy O'Shea, a pioneer in the usage of FTDs also as part of the recurrent training, and Michael Kircher. Captain O'Shea highlighted the difficulty they experienced in incorporating FTDs into the recurrent training, because the competent authority's expectation was that all recurrent FSTD training (min. 12 hours p. a. per crew) should be conducted in an FFS. Austrian Airlines was able to achieve that result with its competent national aviation authority (NAA) because the recurrent syllabus consists of 16 hours p. a. and thus of four hours more than necessary under EASA regulations. In addition, Austrian Airlines does not provide evidence-based training (EBT) yet, which made it possible to move one of the two yearly refresher sessions from the FFS to the Level 2 FTD. In addition, the recurrent syllabus was aligned with the capabilities of the FTD to reflect the above-mentioned limitations.

In regard to type ratings, Austrian Airlines was able to apply the already existing A320 type-rating syllabus, which is standardized across all Lufthansa Group A320 operators. This syllabus enables the transfer of two sessions from a flat panel trainer (FPT) as well as three sessions from an FFS to the Level 2 FTD.

1.3 Best practices to integrate Level 2 FTD into training

Based on the extensive experience and very intense first year of preparing and integrating Level 2 FTD into the training program of Austrian Airlines, four key elements have been identified:

1) Communication is key:

There are many expressed reservations from cockpit crew members against training on an FTD. One argument against it is that without motion the training cannot be realistic. Another point of view is that the training is inefficient and cheap. According to Michael Kircher, this is a normal reaction in a change of standards. Listening to the concerns is the first step; communicating lived experiences, how a change is going to be implemented, and that the trainees are going to be able to provide feedback – those are the key factors for the successful integration of such new devices.

2) Form an agile implementation team to cover all relevant aspects:

Based on the SCRUM methodologies, the team at Austrian Airlines formed a small and interdisciplinary team with a clear vision. Experts came from relevant areas with a strong practical, technical, safety or compliance expertise. Furthermore, frequent and regular meetings are vital for creating a continuous exchange aimed at establishing a new training routine. In addition, the various work results were exchanged with external stakeholders, e. g. other operators and especially the respective NAA.

3) Task-to-tool approach:

The way to implement Level 2 FTDs in the training mix is to integrate a lot of additional training in the plan first, gain relevant experiences and then assign the right tasks to the respective device. The preferred way to train the take-offs and landings is in an FFS but manual flying tasks can be very efficiently trained in a Level 2 FTD.

4) Rethink and redesign training:

Austrian Airlines had slightly adjusted their training to get the most out of the Level 2 FTD. The recommendation is to divide the previous training program into tasks that entail motion and those that do not, as well as into procedural tasks. Level 2 FTDs can even be used in recurrent trainings.

2. HALF-WAY DONE – STATUS QUO AND CHALLENGES OF FIXED-BASE FSTDS

2.1 The controversy – motion training vs. non-motion training

The controversial discussion about the amount of motion training that is necessary is potentially as old as the professional flight simulation industry itself. While until the late 20th century fixed-base FSTDs where preferred over FFS with "bad" motion, this situation completely changed over the past three decades due to significant improvements in motion-cueing technology. Therefore, training was increasingly only considered effective when conducted on an FFS. For example, the minimum EASA-required FFS hours within a type rating amount to 16 hours[2], while the average industry syllabus contains around 48 hours of FFS training, i. e. 200% more than mandated. As one of the panellists put it very generally: *"If you only have a hammer as a tool, you see every problem as a nail."*

In parallel to these industry developments, scientific research continuously tries to evaluate whether or not motion has a significant training impact and, if it does, for which training tasks, specifically. Generally speaking, results of motion training versus those of non-motion training have been somewhat mixed, if not to say indistinguishable. For example, a study series by Bürki-Cohen et al. (2003, 2005, 2007, 2010) revealed some interesting aspects concerning critical flight phases with abnormal procedures, such as engine-out events during take-off as well as during approaches with the latter coinciding with severe weather conditions. On the one hand, pilots conducting non-motion training reacted slightly slower, less than 0.5 seconds, on an engine-out event during take-off. Nevertheless, this barely measurable difference disappeared as soon as this training task was conducted on an FFS with motion switched on. This is in line with the fact that motion cues are perceived within approx. 0.15 seconds, while visual cues are perceived after approx. 0.5 seconds. The delta thus equals 0.35 seconds, which is in line with the measured difference mentioned above.

Interestingly, this variation of less than 0.5 seconds in reaction time decreased during non-motion training with a vibrating seat. This is an interesting finding, as it qualifies the importance of six-degrees-of-freedom FFS motion. It suggests that motion cues do enhance the training outcome but that they do so already on a much lower fidelity level, therefore acting as a "sense and awareness trigger", which is superseded within milliseconds by the visual or instrument information. This indicates that a rudimentary motion cue in connection with a modern collimated visual system could potentially deliver, for certain training tasks currently considered "full motion only, the same training outcomes as if it were conducted on an FFS".

Being not just relevant for the research series outlined above, the researcher questioned whether or not the observed delta in reaction time is actually operationally relevant. As seen in the case of Austrian Airlines, all panellists agreed that there are certain training tasks that require FFS training with motion. As

[2] The minimum hours required on an FSTD amount to 32 hours of which a minimum of 16 hours need to be conducted on an FFS, according to Appendix 9 of Part-FCL.

Michael Kircher highlighted, especially the scientifically researched training task of an engine failure during take-off that is mentioned above needs a motion input. Therefore, operators do consider these delta effects in regard to timing as operationally relevant. Nevertheless, it will be interesting to see how these assessments will develop with operators collecting more fixed-base FSTD training experiences as well as with evolving technologies, such as vibrating seats, in the upcoming decade.

In addition, non-representative studies as well as preliminary studies have been conducted that indicate a high effectiveness of the training on a Level 2 FTD. For example, Philipp Adrian mentioned a non-representative trial where 20 pilots were divided into two groups. One group trained only on an FFS and the other group trained two sessions on a Level 2 FTD. Afterwards, all 20 pilots took the same type-rating skills tests with no deviations in the results. This is not a scientifically sound result but practical indication of the effectiveness of this type of training tool.

An interesting question the audience raised is if there may be a lack of long-term effectiveness, e. g. shorter memory effects, by training on a Level 2 FTD to a larger extent. The panellists agreed that this question would be of high interest for the professional aviation training community. Another idea brought up by Peter Zaal was the transfer of training studies conducted with military jet aircraft, as there is extensive research as well as experience in fixed-base training, including de-coupling the instructor from the direct cockpit environment.

Overall, motion FFS training will continue to play a vital role in the world of modern aviation training. Nevertheless, the industry reached a fidelity level of FFS at which further improvements are not likely to generate significant training improvements for pilots. Rather, the question is how enhanced fixed-base FSTDs as well as newly emerging technologies like virtual reality can be incorporated into existing FFS-heavy training syllabi.

2.2 Evolving technologies and a forward-looking regulation

To answer this question, it is obviously necessary to look at the current and future regulatory regime. For the purpose of this whitepaper, this is only done for the regulatory body EASA. As suggested in the previous chapter, under current EASA regulation it is very difficult to include suitable new technologies into the training syllabus. This is mostly due to path-dependency effects leading to the FFS being the preferred tool for training over the past decades. Besides FFS Level D[3], there are only FTDs as well as flight navigation procedure trainers (FNPT) with only two qualification levels[4] each. In addition, FNPTs are normally only applied during *ab-initio* training or rather pilot school training. Therefore, there are only three

[3] ,Levels A, B, and C are considered non-relevant for new devices and only apply for grandfather rights (G), especially for level CG.

[4] FTD Level 1 (e. g. flat panel trainers, if qualified) and 2, FNPTs Type I and II as well as the additional qualification multi-crew cooperation (MCC).

potential device categories available for regular air operator certificate (AOC) training as well as approved training organization (ATO) training (FFS Level D, FTD Levels 1 and 2).

Since professional simulation technology becomes more cost-effective and standardized and increasingly profits from cross-industry developments (e. g. from the gaming industry), the three categories above are not able to reflect the potential of new FSTDs in aviation training. As Daan Dousi outlined during the panel discussion, this fact was one of the drivers for EASA to initiate a regulatory change process in the past decade, the results of which will be published by 2024[5] following a two-year transition period.

EASA acknowledged the accelerating process of technological innovations and it recognized that the classic regulation approach with its long change cycles cannot keep up with these developments. Therefore, EASA worked together with industry participants ranging from airlines, aircraft original equipment manufacturers (OEM), training device manufacturers (TDM) to NAAs and FSTD providers. As a result, the future requirement for a training tool will strictly follow a task-to-tool approach. Up until now, and as outlined in previous chapters, the regulatory approach as well as the industry approach were based on following a tool-to-task approach. To put it differently, EASA wants to move the industry away from the approach asking "Which training tasks can be conducted on an FFS?" and towards the approach asking "What does the FSTD needs to capable for this specific task?" Based on this, panellist Peter Zaal added that this approach is in line with what has been observed in the area of astronaut training. He stated that the training outcome improved with a combination of tools focusing on different training aspects rather than using just one specific tool for all tasks. But what will this transformation look like?

As outlined in chapter 1.1, EASA will adopt the FSTD system architecture logic of ICAO Document 9625, which breaks down FSTDs into twelve different system areas. In addition, to each system area one of four different fidelity levels[6] will be assigned to generate am FSTD capability signature (FCS). As seen in illustration 1, this will determine a unique set of system capabilities for any given FSTD. In fact, today there are only five relevant FSTD training categories[7]. This number would increase, in theory, to up to 16.8 million[8] unique training device combinations. In addition, FSTD operators would be free to choose how they specify new FSTDs and which FCS combination they will apply for qualification. This means that every initial qualification conducted by NAAs can incorporate the latest available technology to reach a certain fidelity level in a certain system area.

Furthermore, the regulation for ATO-related trainings, e. g. type ratings, is also aligned with the new FCS logic, meaning that every mandatory training task is assigned a minimum FCS which an FSTD has to meet in order to be suitable to the specific training task. Therefore, there is direct link between the upcoming CS-FSTD Issue 3 with the updated acceptable means of compliance (AMC) of Appendix 9 of Part-FCL[9].

[5] Please refer to EASA terms of reference (ToR) rulemaking task RMT.0196 as well as European Plan for Aviation Safety (EPAS) 2020-2024 (page 110, RMT.0196).

[6] Requirement levels (from high to low): Specific (S), Representative (R), Generic (G), and None (N)

[7] FFS Level D, FTD 1 and 2, FNPT I and II (+ add-on multi-crew cooperation (MCC) for FNPTs)

[8] Four fidelity levels to the twelfth power of system categories.

[9] Appendix 9 to Aircrew Part-FCL to Commission Regulation (EU) No 1178/2011.

Consequently, once a training syllabus has been established, an ATO needs to define the minimum fidelity level per system area per session and would then check for the FCS of the desired FSTD.

Nevertheless, it was acknowledged by the panellists that this introduces a large amount of complexity for the industry, at least in the beginning. As described above, the spectrum of potential FSTD layouts will be significantly greater than it is today, especially for training below level D FFSs. On the other hand, the strict FCS logic opens the path to further digitisation. The training tasks of a specific session, for example, could automatically define the minimum FCS footprint for each session. This minimum FCS could then be checked with a database that contains information about the specific FCS of one or more FSTDs.

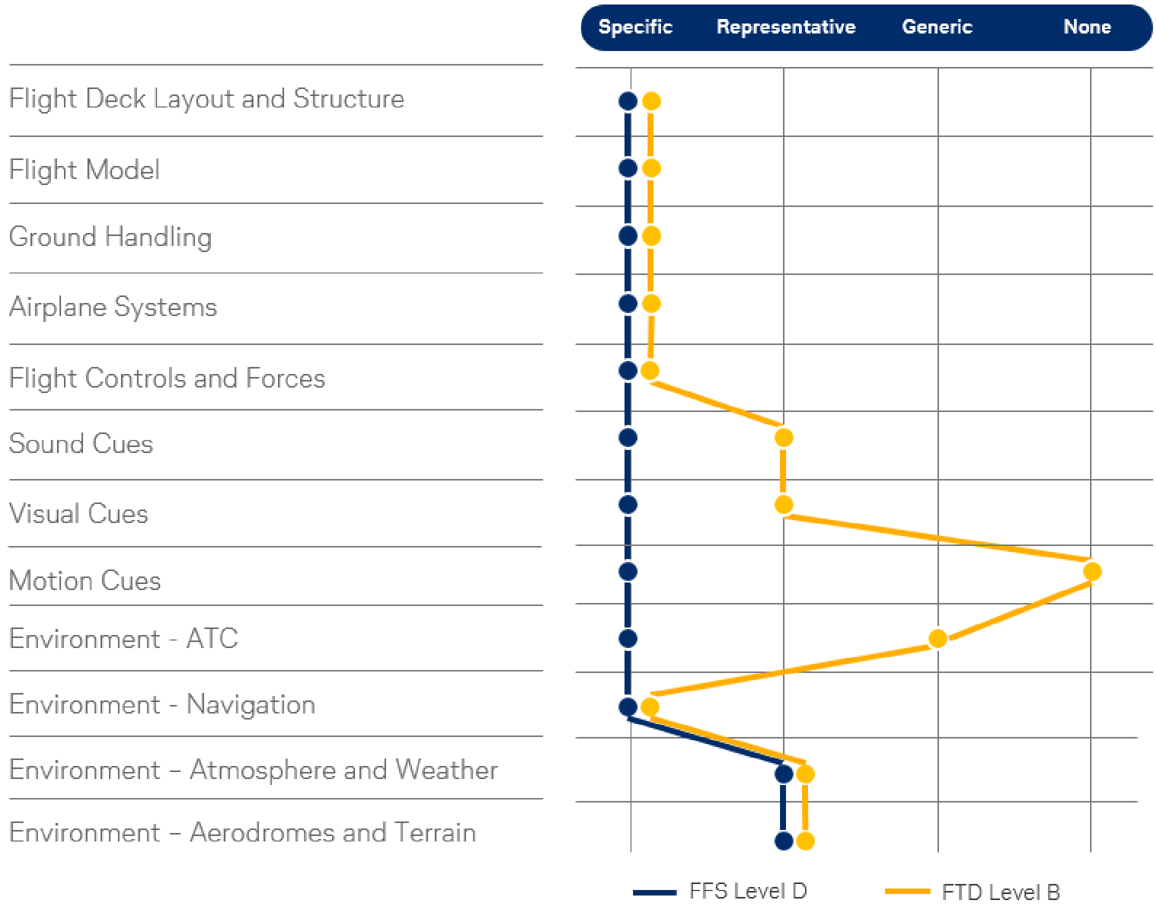

Illustration 1: FCS footprint of newly proposed CS-FSTD(A) Issue 3 for selected FSTDs, namely FFS Level D and FTD Level B, which is closest to the current Level 2 FTD. Source: EASA Notice of Proposed Amendment (NPA) 2020-15, p. 134.

2.3 What about evidence-based training

As seen in the previous chapter, EASA established a direct link between FCL training and the CS-FSTD(A) Issue 3. In addition, under legacy recurrent (Part-ORO[10]) training this is not the case. While the twice-yearly LPC/OPCs need to be performed on an FFS, this does not apply to the one or two refresher sessions a year, depending on the syllabus. In fact, this opened the way for Austrian Airlines to transfer one of their refresher sessions every year to a Level 2 FTD. And what about evidence-based training (EBT)?

The challenge with EBT lies in using a non-FFS device as described in the latest revision of AMC1 ORO.FC.231(e):

"Volume and FSTD:

a) The EBT programme has been developed to include a notional exemplar of 48 FSTD hours over a 3-year programme for each flight crew member.
b) Subject to ORO.GEN.120, the operator may reduce the number of FSTD hours provided that an equivalent level of safety is achieved. The programme should not be less than 36 FSTD hours.
c) Each EBT module should be conducted in an FSTD with a qualification level adequate to complete proficiency checks; therefore, it should be conducted in a full-flight simulator (FFS) level C or D."

As can be seen, letter a) and c) together represent a very formal threshold for including Level 2 FTD or other emerging devices. This has been addressed from the industry towards EASA as the current regulation seems to contradict the intention of the NPA 2020-15 process. On the one hand, airlines could postpone EBT implementation as much as possible, so they can utilize FTDs within their recurrent training longer as this is also a question of economic efficiencies. On the other hand, airlines that already perform EBT do face great challenges when it comes to incorporating FTDs into their programme. Even though letter b) would allow, in theory, some flexibility[11], feedback received by LAT shows that most airlines performing EBT do not see this option as a potential way forward.

Further evolvement of the EBT regulation to increase clarification for airlines and national aviation authorities will be necessary in the upcoming years. Otherwise, market penetration of (innovative) non-FFS devices will remain rather superficial. To further address this challenge, EASA is in the consultation process with ICAO's EBT project to "start the journey" in regard to this topic.

[10] Air Operations Part-ORO to Commission Regulation (EU) No 965/2012.

[11] E. g. training 12h p. a. on an FFS under the minimum EBT requirement and an additional 4h p. a. on a Level 2 FTD. Nevertheless, this is subject to the specific circumstances of the respective AOC as well as its overseeing NAA.

3. FUTURE SCENARIOS AND DEVELOPMENT NEEDS

3.1 Fly global – train local?

While so far this paper only explored necessary changes purely from the training and technology sides, there is obviously more to the field of future aviation training. It is indisputable that training in the aviation world needs to serve the overall goal of safe aircraft operations. At the same time, the aviation industry is facing enormous challenges. Amongst others, the COVID-19 pandemic as well as the global climate discussions are just two of the main drivers to develop more efficient and effective new training approaches.

The changes in the aviation industry parallel the above-mentioned macro-developments. Due to increased standardisation and easier-to-handle commercial off-the-shelf (COTS) technology, the number of FFS training centres in Europe increased significantly, while at the same time on average fewer FFS were in operation per centre[12]. This already reflects the trend of training as close as possible to an airline's home base. This is preferred because of cost, health (pandemic) and environmental reasons. Increased usage of Level 2 FTD as well as other new and innovative training tools such as virtual-reality solutions will only enhance this trend. As a result, the competition in the aviation training industry will further increase, especially within the FFS segment.

Therefore, the trend of training mainly at your airline (home) base and as locally as possible will continue to develop in the upcoming decade. This will in turn favour the incorporation of less capital-intensive Level 2 FTD into the training syllabus. As discussed in the previous chapter, resolving the challenge of EBT and FFS requirements is likely to unleash a change in the European aviation training unlike anything else in the past two to three decades. Overall, there was a common understanding among the panellists that Level 2 FTDs will play an important role in reducing the industry's carbon footprint. In addition, it was a common expectation among the panellists that level 2 FTDs will even increase safety because of more training opportunities[13] and will likely lead to better training outcomes because of their specific design[14].

3.2 Pilot training in 2030 and beyond

Pilot training in 2030 and beyond will presumably still look a lot like pilot training in 2021, meaning that FFSs will remain the backbone of professional pilot training. Nevertheless, their dominance or market share across all trainings is expected to decrease over time. As already seen, and with EASA introducing

[12] Based on LAT's own market research.

[13] Lower investment and lower infrastructure requirements compared to an FFS.

[14] Task-to-tool approach.

a more flexible regulation that is specifically open towards technological innovations, the industry will experience a significant leap in how training will be delivered. Level 2 FTD are just the beginning and will be followed by training tools that serve other training needs and that do not even require the technical setup of such a fixed-base FSTD. While currently flat panel trainers and, to some extent, web-based as well as computer-based trainings fill this gap, by 2030 completely new training tools will be emerging.

In the short term, for example, LAT will introduce a motion-based mixed-reality FSTD to its pilot school in Switzerland. This device, which represents a single-pilot cockpit of the Diamond DA-42 training aircraft will be used to conduct any additional training student pilots might need. Therefore, instead of using the real aircraft, student pilots whose performance is not sufficient in specific tasks will train on this FSTD until they are ready to move on to the next training phase on the real aircraft. The device utilizes a motion system within a very confined space with only minimal infrastructure requirements. In addition, and most innovative, the cockpit itself is fully replicated but the outside visual is realized via the latest available mixed-reality technology. Mixed-reality means, in this case, that everything inside the cockpit, e. g. panels, paper checklists or the pilot's hands, can be seen via a live video feed from cameras mounted on top of the mixed-reality headset. Nevertheless, as soon as the pilot's line of sight moves outside the cockpit, the computer will place an overlay projecting the actual visual simulation of the environment.

Obviously, developments like the Level 2 FTD or mixed-reality FSTDs, with or without motion, will not stop at the current stage and will evolve further. At LAT, we believe that pilot training will move away from the traditional computer-based and web-based trainings, away from FPTs and FFSs and towards more training on non-FFS devices as well as towards replacing the FPTs and to some extent CBTs/WBTs with new types of training tools; away from enhanced fixed-base FSTDs like Level 2 FTD to different combinations of devices utilizing augmented, virtual, or mixed-reality[15].

3.3 What now?

During the panel discussion a common desire emerged to find a way to reach a sustainable industry standard of using Level 2 FTDs. These devices can already be incorporated into today's training environment, but still lack a standardised way forward to implementation. This will change for the EASA world with NPA 2020-15 and its proposed changes to Part-FCL training as well as the FSTD qualification logic. The enhancement of the respective regulations will enable training departments to be more confident in the capability of an FSTD (see FCS), which will make it easier to assign non-FFS training tasks to the appropriate FSTD. In addition, these industry developments will also open the space for an easier application of newly emerging technologies, e. g. mixed-reality FSTDs etc.

Nevertheless, the industry will continue to face challenges when it comes to incorporate this task-to-tool paradigm shift. Firstly, the panellists expect a great need for increased communication among FSTD

[15] 'Augmented reality' means placing an overlay onto the person's actual line of sight, e. g. head-up displays. 'Virtual reality' means that every visual information is shown on a screen with no direct outside view. 'Mixed-reality' refers to the approach of enhancing the direct view into the real world, e. g. via cameras, by augmenting, or placing virtual overlays onto, the picture.

operators as the new logic differs significantly from what stakeholders are used to today. This applies not only to customers and NAAs within EASA, but outside the EASA jurisdiction, as well. Secondly, the complexity of qualification information increases from one specific level, e. g. level D FFS, to an FCS with twelve system areas, each with different capability levels. To minimize this complexity, EASA proposes guidelines on certain FSTD categories and levels for guidance as seen in table 1. This means that a certain FCS can be matched with a certain qualification level, e. g. FTDs Level B under CS-FSTD(A) Issue 3. Nevertheless, for the industry it would be also very important to have a standardised application programming interface (API) for FCSs in order to be able to deploy digital tools that automatically match a required FCS of a training task with the FSTD available in Europe. Thirdly, further regulatory approaches need to be evaluated with a view to how using non-FFS devices can be feasible in the future for EBT and under which circumstances, as this can be a major barrier for airlines when it comes to implementing EBT or to making stronger use of non-FFS devices where suitable for specific training tasks.

			FSTD features											
			Aircraft					Cueing			Environment			
FSTD type	FSTD level	ICAO equivalent type	Flight deck layout and structure	Flight model (aero and engine)	Ground handling	Aeroplane systems	Flight controls and forces	Sound cues	Visual cues	Motion cues	Environment — ATC (*)	Environment — Navigation	Environment — Atmosphere and weather	Environment — Aerodromes and terrain
FFS	D	VII	S	S	S	S	S	S	S	S	S	S	R	R
FTD	B	V	S	S	S	S	S	R	R	N	G	S	R	R
	A	N/A	G	R	G	S	G	G	N	N	N	S	G	N
FNPT	E	VI	R	R	R	R	R	R	S	R	S	S	R	R
	D	IV	R	G	G	R	G	G	G	N	G	S	G	R
	C	III	R	R	R	R	R	G	R	N	N	S	G	G
	B	II	G	G	G	R	G	G	G	N	G	S	G	G
	A	I	R	R	R	R	R	G	R	N	N	S	G	R
			FSTD feature fidelity levels											

Table 1: FCS summary matrix with proposed guidelines for FSTD categories (highlighting in the original). Source: EASA NPA 2020-15, p. 134.

Last but not least, the aviation industry needs to constantly identify opportunities to enhance its training setup by being open-minded vis-à-vis new ideas and technologies and by testing them in a small and manageable environment until proof of concept is realised. Therefore, it is not about replacing the FFS just to be "modern" but actually about enhancing training while simultaneously realizing economic as well as ecological benefits.

ABBREVIATIONS

AMC	Acceptable Means of Compliance
AOC	Air Operator Certificate
API	Application programming interface
ATC	Air Traffic Control
ATO	Approved Training Organization
COTS	Commercial Off-The-Shelf
CS-FSTD(A)	Certification Specification Flight Simulation Training Devices (Airplane)
EASA	European Union Aviation Safety Agency
EBT	Evidence-Based Training
FCL	Flight-Crew Licensing
FCS	FSTD Capability Signature
FFS	Full-Flight Simulator
FNPT	Flight Navigation Procedure Trainer
FSTD	Flight Simulation Training Device (consists of FFS, FTD, and FNPT)
FTD	Flight Training Device (as per CS-FSTD(A) Issue 2)
ICAO	International Civil Aviation Organization
LATC	Lufthansa Aviation Training Center
MCC	Multi-Crew Cooperation
MPL	Multi-Crew Pilot License
NAA	National Aviation Authority
NPA	Notice of Proposed Amendment
OEM	Original Equipment Manufacturer

ORO	Air Operations
TDM	Training Device Manufacturer

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