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Simulator fidelity requirements for upset prevention & recovery training

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Executive summary

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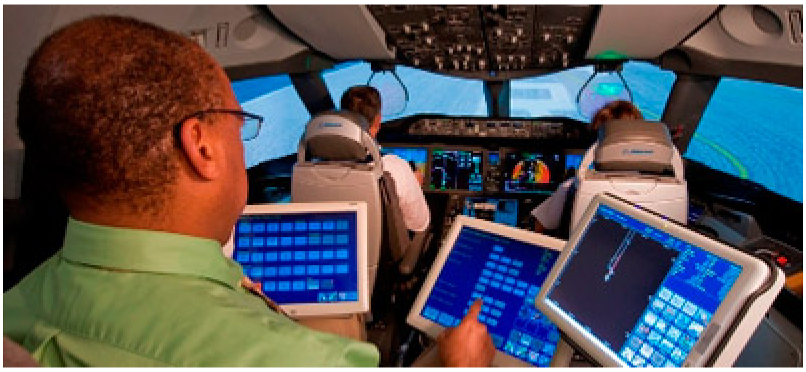

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Problem area

The aviation industry has identified the need for improvements to flight crew training to prevent Loss of Control – In Flight incidents and accidents.

The International Committee for Aviation Training in Extended Envelopes (ICATEE) was established by the Royal Aeronautical Society to investigate the current training programmes and facilities and recommend improvements to aviation regulatory organisations such as ICAO, the FAA and EASA.

One of the sub working groups of ICATEE is investigating simulator fidelity requirements in order to make simulator standards recommendations. This paper will describe the process of aligning the training objectives, identified by the ICATEE training group, with training devices in support of a comprehensive upset prevention and recovery training program.

Description of work

A Human Factors and Training analysis was carried out within the ICATEE working group by a group of experts from across the aviation industry. The analysis was based on the training tasks and objectives defined in the ICATEE upset prevention & recovery training matrix.

Each training task was analysed by Human Factors experts for the cues that were critical to achieving the training objective. This analysis was then used to establish the required fidelity for simulator features.

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This report is based on a presentation held at the Royal Aeronautical Society Flight Crew Training Conference, London, September 25 & 26, 2013.

Results and conclusions

The analysis of the simulator features and associated fidelity level required defined the requirements for simulator devices. It was compared with existing devices defined in ICAO Document 9625.

This comparison led to the identification of four supplemental device types, one of which was a modification of the existing ICAO Type VII device.

The analysis of training tasks shows that the majority of the ICATEE training programme can be carried out using existing devices, and is enhanced by minor modifications to existing devices. The remaining tasks can be trained in a light aerobatic-capable aircraft.

Applicability

This paper applies to all flight simulation training devices that could be used for upset prevention & recovery training.

The results of the paper can be used to inform the improvement of FSTDs to support Upset Prevention and Recovery Training (UPRT) programmes. The process that is described in this paper can further be applied to the analysis of simulator requirements for other additional training tasks.

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Simulator fidelity requirements for upset prevention & recovery training

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This report is based on a presentation held at the Royal Aeronautical Society Flight Crew Training Conference, London, September 25 & 26, 2013.

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Summary

This paper will describe the process of aligning the training objectives, identified by the ICATEE training group, with training devices in support of a comprehensive upset prevention and recovery training program. It will summarize the training device feature fidelity analysis used to determine the required device for a given training task. The paper will identify existing devices, enhancements required to existing devices or new devices needed to meet all of the training tasks contained in the matrix.

Contents

Abbreviations

AoA	=	Angle of attack
ATC	=	Air Traffic Control
FTD	=	Flight Training Device
FFS	=	Full Flight Simulator
FSTD	=	Flight Simulator Training Device
GAD	=	G-Awareness Device
ICAO	=	International Civil Aviation Organisation
ICATEE	=	International Committee for Aviation Training in Extended Envelopes
IOS	=	Instructor Operating Station
LOC-I	=	Loss of Control In-flight
R & T	=	Research and Technology
SPD	=	Spin Training Device
SDD	=	Spatial Disorientation Device
UPRT	=	Upset Prevention and Recovery Training

1 Introduction

The International Committee for Aviation Training in Extended Envelopes, ICATEE, is an initiative of the Royal Aeronautical Society aimed at bringing together the world's flight training and simulation technology experts to develop guidelines for Upset Prevention and Recovery Training (UPRT). The main goal of the group is to address Loss-of-Control In-flight (LOC-I) accidents, which currently are the leading cause of fatalities in the worldwide commercial jet fleet. ICATEE believes that an integrated approach is needed to learn how to prevent and recover from an upset. Such an approach combines knowledge (academics), simulators, and actual aeroplane training. Defining what, and how much, training should go into each approach has been the subject of much debate. This paper describes the process of determining the technical requirements for UPRT that are driven by the training needs defined by the ICATEE training group. This process led to the establishment of Flight Simulation Training Device (FSTD) standards for UPRT, as well as the definition of fidelity requirements for the training tasks in the UPRT programme.

2 Background & Method

The matrix of training tasks for UPRT that was developed by the ICATEE training subcommittee forms the basis for the training device requirements analysis. The training matrix identifies 176 training tasks for a comprehensive UPRT training programme. These tasks are identified for three mitigation levels:

- **Awareness -** knowledge and skills necessary to provide pilots with an appreciation of the concepts, principles, techniques, and procedures that can be valuable in understanding upset hazards, assessing risk, and employing recovery strategies
- **Prevention -** information specific to recognizing and avoiding the hazards associated with unexpected aeroplane upsets and in-flight loss-of-control events
- **Recovery -** knowledge, skills, techniques, and procedures required to return an aeroplane to safe flight

Each training task, or element, is identified alongside a learning objective for the task. The learning objective along with the requirement for practical training formed the basis for the fidelity analysis.

The example below (Table 1) is an excerpt from the Awareness mitigation level of the training matrix and illustrates some of the key components of the matrix.

Table 1 Training Matrix Excerpt

Training Element	Academic	Practical	Device Level[1]	Learning Objective	Remarks	Training / Training Proficiency[2]	Recurrency
High AOA Performance Consideration	X	X	FTD	Understanding of the relationship between high Angle of Attack (AoA) and increased induced drag		T	YES
High Altitude Stall	X	X	FFS	Demonstration of stall recoveries, altitude loss, recovery with reduced thrust/power and other performance differences associated with high altitude flight		T	YES
Pitot-Static System Failure	X			Depiction of actual instrument indications of various pitot-static system failure modes		T	YES
All Attitude Exposure		X	A	Exposure to 360° of roll and pitch attitudes required to gain appreciation for attitudes from which recovery may be required	Required psychological exposure cannot be provided through simulation	T	YES

The fidelity analysis focused on the training elements that included a practical requirement (the 3rd column in the table above). Those tasks identified as purely academic were not included. So in the above example the third task (Pitot-Static System Failure), which is academic and not practical, did not require a fidelity analysis. The learning objective provided the key objective of the training element, and could be used to identify the level of fidelity that was required for the practical training environment. Also, the remarks section often included comments intended to assist in the interpretation of the learning objective. Early versions of the training matrix included an initial assessment of the required training device for the practical training by the training subcommittee members (4th column in the example above). While this was not directly used in the fidelity analysis, it did serve as a useful check once the device requirements and resulting training device had been identified.

[1] A – Aircraft; FFS – Full Flight Simulator; FTD – Flight Training Device
[2] T – Training; TP – Training to Proficiency

3 Analysis

For each step of this analysis, the method used was an assessment of the training tasks by experts in their field from the ICATEE group. For example, the cue analysis was carried out by Human Factors experts, and reviewed by representatives from training, simulation, and flight crew. Likewise, the FSTD feature fidelity analysis was carried out by a team of simulation & training experts, and reviewed by other members of the ICATEE group. Initial experiments have been carried out and are still being analysed to test some of the fidelity assessments.

3.1 Cue analysis

The cue analysis was the starting point for the assessment of the training device requirements. Taking each training task where practical training was expected, the required fidelity for the (simulated) cues to support this training was identified. Five categories were used for each training task: Control Forces, Instruments, Visual, Motion and Aural. For each category, an assessment was carried out as to whether this cue was required for the training objective, and if so, it was rated as:

- Physiological effects (p)
- Alerting or Awareness (a)
- Control (of the aircraft) (c)

If a cue was not required, it was marked as such (not required - n). For each cue, the assessment was carried out for its specific relevance to the learning objective identified by the training group. The assessment was carried out by a subgroup of aviation Human Factors experts and reviewed by both the training and technology groups.

The five categories were considered as separate cues – Control Forces relates to the pilots haptic interface via the aircraft controls; Instruments relates to the information exchange with the aircraft via the instruments; Visual, Motion and Aural relates to the cues that are received via the senses that relate to the control (for example, visual or motion feedback of a control input), or alerting & awareness (for example, an aural warning). The physiological effects were identified where the physiological effects of a cue (for example, g-cueing, or spatial disorientation) play a critical role in the learning objective. This process is illustrated by the examples in Table 2, below.

Table 2 Examples of Cue Requirements

Training Element	Academic	Practical	Device Level	Control Forces	Instruments	Visual	Motion	Aural	Learning Objective	Remarks	Training / Training Proficiency	Recurrency
High AOA Performance Consideration	X	X	FTD	c/a	a	n	a	a	Understanding of the relationship between high AoA and increased induced drag		T	YES
High Altitude Stall	X	X	FFS	c/a	a	n	a	a	Demonstration of stall recoveries, altitude loss, recovery with reduced thrust/power and other performance differences associated with high altitude flight		T	YES
Pitot-Static System Failure	X		FTD	c	a	n	n	a	Depiction of actual instrument indications of various pitot-static system failure modes		T	YES
All Attitude Exposure		X	A	c	a	a	p/c	a	Exposure to 360° of roll and pitch attitudes required to gain appreciation for attitudes from which recovery may be required	Required psychological exposure cannot be provided through simulation	T	YES

Cues: a – alerting/awareness; p – physiological; c - control

For the High Angle of Attack (AoA) Performance Consideration, and for the High Altitude Stall, the Control Forces were rated as required for both control and an awareness cue for the pilots. This was considered in terms of being able to achieve the learning objective. For example, to be able to demonstrate stall recoveries at high altitude, the force feedback from the controls is a key element in the skills learning for the pilots. The instrument feedback to the crew is required for both alerting and awareness cues. When considering the Visual, Motion and Aural aspects of these manoeuvres, both Motion and Aural were deemed necessary as part of the awareness cues, but Visual cues were not required.

For the Pitot-Static System Failure task, the control forces are required as part of the pilot's control task in responding to the failure, but do not represent an element of the alerting or awareness cues. In addition, this task was not considered as requiring motion cues in order to achieve the learning objective (which is also reflected in the initial estimate of an FTD device shown in the example table). Since it was considered an Academic only task at the Awareness mitigation level, the analysis was not applied further.

The All Attitude Exposure training task is included to illustrate the consideration of the physiological cues that may be required to achieve the learning objectives. For the All Attitude Exposure task, the motion cues were identified as contributing to both the physiological, and control cues of the flight crew. The physiological effects of the motion cue contribute to the pilot's orientation to motion cues associated with upsets and stalls. In severe cases, the motion may also have an impact on the control cues (and forces) for the pilot.

The aim of the cue analysis was to rate each training task, and so to be able to identify the cues that were critical to the achievement of the learning objective. This rating would then guide the assessment of the current training facilities (such as Level D FSTDs) and help to identify any shortcomings in these facilities. Furthermore, the cue assessment would guide the analysis of how a specific simulator feature fidelity would need to be improved – for example, improving the flight model to support the control forces and instrument cues for the pilots.

3.2 Feature fidelity analysis

The framework for device features in the 3rd edition of the *Manual of Criteria for the Qualification of Flight Simulation Training Devices* (ICAO, 2009) formed the basis of the training device requirements analysis and specification. The analysis that was carried out by the ICATEE R&T team aligned the training objectives from the training matrix with the training device capabilities. This included current training device capabilities, and, where required, specifying new capabilities to satisfy the training objective. The results of this analysis are expected to be incorporated in the next release of ICAO Document 9625.

On the basis of the fidelity analysis, each of the training tasks was then assessed in terms of the thirteen simulator features from ICAO Document 9625:

- Cockpit layout and structure
- Flight Model (aero and engine)
- Ground Handling
- Aircraft Systems
- Flight Controls and Forces
- Sound cue
- Visual cue
- Motion cue
- Environment – Air Traffic Control (ATC)
- Environment – Weather
- Environment – Aerodromes and terrain
- Miscellaneous (includes Instructor Operating Station)

The device features that were applicable to the training task were checked against the device feature fidelity requirements identified in ICAO Document 9625: Not required (N), Generic (G), Representative (R), and Specific (S).

Additional ratings were identified for the features where the existing ICAO 9625 requirements (e.g. Representative, or Specific) did not contain sufficient fidelity, or did not meet the training objective requirements. The following example (Table 3) shows the feature fidelity analysis for three of the tasks used in the earlier example.

For the High AOA Performance Considerations task, a check of the existing feature fidelity requirements indicate that the training objective could be met by the “representative” fidelity level for the device features of importance to this task. This results in an “R” designation for these features in the example below (e.g. Flight Model, Aeroplane Systems, Flight Controls & Forces, etc.).

For the High Altitude Stall task, some features required additional fidelity beyond the existing requirements. For the Flight Model the current requirements call for the model to account for various effects “normally encountered in flight”. This was interpreted to cover the portion of the flight envelope up to the angle of attack for the first indication of stall. To cover the full stall and recovery portions, additional requirements for the flight model were needed leading to a designation of “S1” for that feature’s fidelity level. Improvements to the IOS were needed to provide the instructor with greater visibility of pilot control inputs and provide feedback on whether the training had exceeded the limitations of the simulator. This led to the “S1” fidelity designation for the Miscellaneous – IOS feature. Lastly this task required enhancements to the motion cues (buffet) to support the training objective. This led to the R2 designation for motion cues (R1 is already used in the 3rd Edition of the ICAO 9625 document). The details of these additional fidelity designations (e.g. S1, R2, R3, etc.) are included in the Part B Simulator Standards of the ICATEE Research & Technology report (RAeS, to be published).

Since the Pitot-Static System Failure task was identified as an Academic only training task (for the Awareness training), there was no further consideration of the simulator feature fidelity requirements for this task.

Table 3 Examples of FSTD Feature Fidelity Requirements

Training Element	Academic	Practical	Device Level	Cockpit layout and Structure	Flight Model	Ground Handling	Aeroplane Systems	Flight Controls and Forces	Sound Cuie	Visual Cue	Motion Cue	Environment - ATC	Environment - Navigation	Environment - Weather	Environment - Aerodromes	Miscellaneous - IOS	Learning Objective
High AOA Performance Considerations	X	X	FTD	R	R	N	R	R	R	R	N	N	N	N	N	N	Understanding of the relationship between high AoA and increased induced drag
High Altitude Stall	X	X	FFS	S	S1	N	S	S	R	R	R2	N	N	N	N	S1	Demonstration of stall recoveries, altitude loss, recovery with reduced thrust/power and other performance differences associated with high altitude flight
Pitot-Static System Failure	X																Depiction of actual instrument indications of various pitot-static system failure modes
All Attitude Exposure		X	A	S	S	N	S	S	R	R	R2	N	N	N	N	S1	Exposure to 360° of roll and pitch attitudes required to gain appreciation for attitudes from which recovery may be required

Fidelity: N – not required; G – generic; R – representative; S – specific

When the feature fidelity assessment was complete for all of the tasks in the matrix, enhancements were also required to the Flight Controls and Forces, Visual Cues and Environment – Weather features.

4 Rollup

4.1 Devices – rollup results

Having identified the FSTD feature fidelity requirements for each of the 176 training tasks, the individual ratings were combined. This resulted in nearly 40 unique feature fidelity combinations. Some of these combinations aligned to FSTD types currently identified in the ICAO 9625 document that could satisfy the training task. The remaining combinations were grouped by fidelity levels for key simulation features. This was done to minimize the number of new device types and not negate the efforts of the 3rd Edition of the ICAO 9625 document by significantly increasing the number of devices. The alignment of feature fidelity requirements to training devices was based on judgment. No alternative exists, as experiments have not yet been performed to guide the required capabilities. As such, conservatism was applied out of an abundance of caution. Appendix A2 of the ICATEE Research and Technology Report (RAeS, to be published) contains the results of the entire analysis. This Appendix would allow a device to be qualified for a specific training task, similar to Part III of the 3rd edition of the ICAO 9625 document.

The following example (Table 4) shows the fidelity analysis for three of the tasks used in the earlier example. The fourth column has been added to the table that identifies the minimum device type required to support the training task based on the process described in the previous paragraph. For the High AOA Performance Considerations task the training objective could be met by the existing Type III device.

For the High Altitude Stall task, some features required additional fidelity beyond the existing requirements resulting in a Type VII+ device.

Table 4 Example of Training Device Alignment

Training Element	Academic	Practical	Device Level	Roll-up Device	Cockpit layout and Structure	Flight Model	Ground Handling	Aeroplane Systems	Flight Controls and Forces	Sound Cuie	Visual Cue	Motion Cue	Environment - ATC	Environment - Navigation	Environment - Weather	Environment - Aerodromes	Miscellaneous - IOS	Learning Objective
High AOA Performance Consideration	X	X	FTD	III	R	R	N	R	R	R	R	N	N	N	N	N	N	Understanding of the relationship between high AoA and increased induced drag
High Altitude Stall	X	X	FFS	VII+	S	S1	N	S	S	R	R	R2	N	N	N	N	S1	Demonstration of stall recoveries, altitude loss, recovery with reduced thrust/power and other performance differences associated with high altitude flight
Pitot-Static System Failure	X																	Depiction of actual instrument indications of various pitot-static system failure modes
All Attitude Exposure		X	A	AP	A	A	A	A	A	A	A	A	A	A	A	A	A	Exposure to 360° of roll and pitch attitudes required to gain appreciation for attitudes from which recovery may be required

Fidelity: N – not required; G – generic; R – representative; S – specific; A - Aircraft

A complete analysis of the training matrix shows that a number of UPRT tasks could be met with the existing Type III, V or VII devices. However, some tasks require simulator feature fidelities greater than (ICAO, 2009) Type VII FSTDs, or capabilities differing from ICAO-approved devices. Similar to the High Altitude Stall task example above, some tasks are likely to require a higher fidelity flight model, improved motion cuing, or the ability to generate sustained G forces. In these cases, ICATEE defined five (5) supplemental training devices required to meet all of the tasks contained in the ICATEE UPRT matrix. Fidelity requirements for these devices are briefly summarized as follows:

- **Type VII+ Training Devices** are not new devices per se but result from upgrading existing Type VII devices. Additional requirements were defined to enhance the following features:
  - flight models
  - flight control responses and control forces
  - motion cuing
  - environmental/weather capabilities
  - instructor operating stations
- **Type GAD - G-Awareness Devices** are capable of generating sustained load factors to support G-awareness training.
- **Type SPD - Spin Training Devices** constitute an upgrade of the Type VII FSTD beyond that required for a Type VII+ device, should spin training become a requirement and simulators be used for that purpose. These devices replicate the rapid attitude changes and sustained G forces experienced in a spin manoeuvre and are characterized by a flight model more sophisticated than those of Type VII+ devices.
- **Type SDD - Spatial Disorientation Training Devices** support tasks where enhanced visual and motion cues and sensations cannot be replicated readily in a flight simulation training device.
- **On-Aeroplane Training** is required for tasks where physiological and psychological effects can be experienced only in an all-attitude/all-envelope environment that cannot be replicated using current simulator technology. The ICATEE Training group also identified tasks that would initially be trained on an aircraft, but for recurrent training would be performed in a FSTD. These tasks have their device noted as an A* in the training matrix.

A summary of the existing and new FSTDs is presented in the matrix below (Table 5).

Table 5 FSTD Summary Matrix

ICAO 9625 TYPES	Cockpit layout and Structure	Flight Model	Ground Handling	Aeroplane Systems	Flight Controls and Forces	Sound Cuie	Visual Cue	Motion Cue	Environment - ATC	Environment - Navigation	Environment - Weather	Environment - Aerodromes	Miscellaneous - IOS	
SDD	G	G	N	G	G	G	R2	R4	G	S	G	G		New Devices
SPD	S	S2	S	S	S	R	S	R3	N	S	R	R	S1	
GAD	G	R	N	G	R	G	R2	R3	N	N	N	N	S1	
VII+	S	S1	S	S	S1	R	S	R2	N	S	R2	R	S1	
VII	S	S	S	S	S	R	S	R	S	S	R	R		Existing devices
VII	S	S	S	S	S	R	S	R	N	S	R	R		
VI	R	R	R	R	R	R	S	R1	S	S	R	R		
V	S	S	S	S	S	R	R	N	G	S	R	R		
IV	R	G	G	R	G	R	G	N	G	S	G	R		
III	R	R	R	R	R	G	R	N	N	S	G	G		
II	G	G	G	R	G	G	G	N	G	S	G	G		
I	R	R	R	R	R	G	R	N	N	S	G	G(S)		
I	R	R	R	R	R1	G	G	N	N	S	G	G		
I	R	R	R	R	R	G	R	N	N	S	G	R(S)		

Fidelity: N – not required; G – generic; R – representative; S – specific

It should be reiterated that the VII+ device requirements could readily be merged with the existing Type VII requirements. However due to questions of whether the requirements are retroactive, or if full stall recovery training is mandated, it was decided to keep them separate for this initial analysis. Detailed fidelity requirements for the above devices are defined in Part B of the ICATEE R&T document (RAeS, to be published) for each of the simulation devices and will be discussed in greater detail in another paper presented at this conference. For the Type VII+ device, the requirements have been defined to include objective as well as function and subjective test requirements. It is expected that tasks assigned to GADs and SPDs will initially be completed in a training aeroplane and transferred to a flight simulation device in the future. Devices equivalent to the Types SDD and GAD currently exist and may suffice depending on the results of requirement formulation.

Each task in the training matrix was eventually assigned to one of nine training devices required for its delivery: None (Academic Only); ICAO Type III, V, and VII FSTDs; Device Types VII+, GAD, SPD, and SDD; and aeroplane. Table 6 provides the distribution of the 176 UPRT tasks defined in the training matrix across the mitigation levels and device types.

Table 6 Training Tasks Distributed by Device Types

Device	Awareness	Prevention	Recovery	Total Tasks	% Total Tasks
Training Tasks that Use Existing ICAO-Approved Simulation Devices					
None (Academic only)	8	13	33	54	30.7%
Type III	2	0	4	6	3.4%
Type V	1	5	2	8	4.5%
Type VII	1	11	19	31	17.6%
Subtotals	12	29	58	99	56.3%
Training Tasks that Use Non-Existent or Non-ICAO Approved Simulation Devices					
Upgraded Type VII+	7	22	17	46	26.1%
Spin Training Device	3	2	3	8	4.5%
G Awareness Device	4	3	3	10	5.7%
Spatial Disorient. Device	0	1	1	2	1.1%
Aeroplane	3	2	6	11	6.3%
Subtotals	17	30	30	77	43.7%
Summary					
Task Totals	29	59	88	176	100.0

Table 6 reveals that 99 of 176 training task (56%) can be performed using existing ICAO-approved technology. Fifty-four of these 99 tasks (31%) involve ground-based academic training not requiring a device. While 45 of the 99 tasks (25%) can be performed in a Type III, V, or VII FSTD, with 31 tasks (18%) requiring a Type VII device.

The remaining 77 tasks (44%) in the training matrix require an upgrade of, or addition to, a currently approved ICAO device. Spin, G-awareness, spatial disorientation, and on-aeroplane training together account for 31 tasks (18%) of the 77. Moreover, all of these 31 tasks, except 2 spatial disorientation-training tasks (1%), can reliably be delivered in light aeroplanes. However, the 46 remaining tasks (26%) require a Type VII+ device.

In summary, over 3/4 of 176 tasks in the training matrix can be accomplished with today’s devices or today’s devices with some modest improvements. The data in column six of Table 6 are displayed graphically in Figure 1.

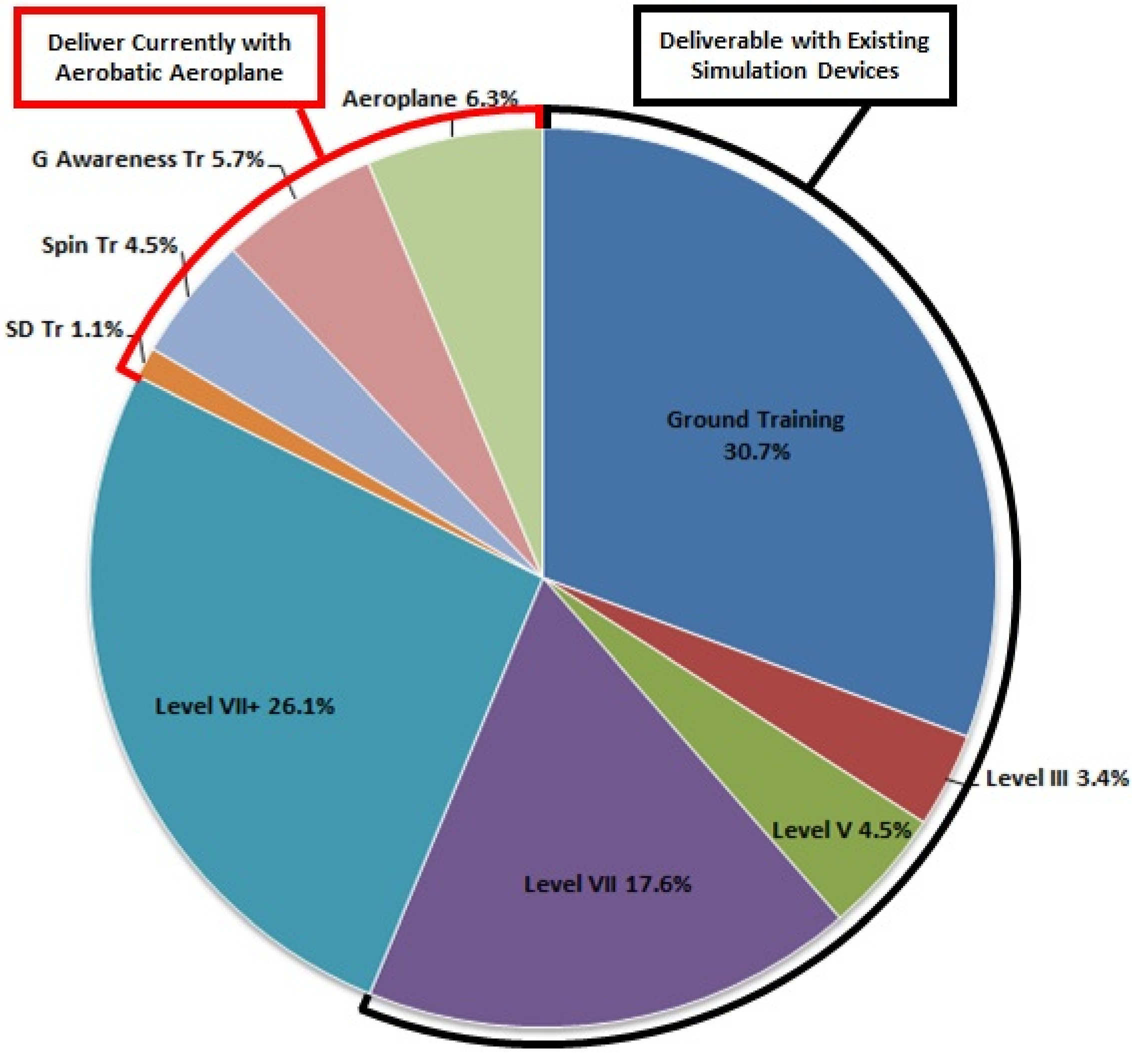

Figure 1 Distribution of UPRT Tasks by Device Type

5 What's next

The feature fidelity analysis carried out by this ICATEE team has been used to define the Part B simulator standards section of the ICATEE R&T report (RAeS, to be published). This Part B has, in turn, been provided to ICAO, the FAA and EASA to inform the ongoing work to establish simulator standards to support UPRT. It is expected that portions of Part B will be the basis for a future update of the ICAO Document 9625 providing guidance on the FSTD fidelity requirements for UPRT programmes.

The feature fidelity requirements and subsequent training device alignment described above were driven by the training needs. For this effort, those training needs were captured in the training matrix developed by the ICATEE training group. If the training objectives change due to new regulatory requirements or the introduction of new aircraft technology, the technical requirements will need to be reviewed.

One area where regulations are currently being defined is related to stall training. Approximately 50 of the 176 training tasks in the ICATEE training matrix are related to stall. This is largely in response to the passage of the Airline Safety and Federal Aviation Administration Extension Act of 2010. This U.S. law requires stall and upset recognition and recovery training (Public Law 111-216, 2010). What if the training objectives were limited to approach to stall instead of full stall? An initial assessment of the training matrix shows that this would essentially eliminate the need for the Type SPD (Spin Training Device) and significantly reduce the number of tasks performed on an aircraft. The number of tasks requiring a Type VII+ device would also be reduced by roughly two-thirds; but not eliminated. This is an example of how the technical requirements for FSTDs are driven by training needs; and as the training needs change, the technical requirements must follow.

6 Summary

This paper has traced the definition of training devices to support a comprehensive UPRT program, including recovery from full stalls. Based on the tasks and objectives contained in the ICATEE training matrix, cueing and FSTD feature fidelity requirements were determined to support a given training task. Each task was then aligned to an existing FSTD device or a new device. One of the 5 new devices identified is a Type VII+ device. This device represents some modest enhancements to today's highest level of FSTD (Type VII). Over ¾ of the tasks contained in the training matrix can be accomplished in existing devices or the VII+ device. It is expected that the Type VII+ requirements will eventually be combined with the existing Type VII device requirements in future revisions of regulatory material.

Acknowledgements

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