Experiencing SATCE in training – perspectives from trials of this new training technology

Abstract — Simulated Air Traffic Control Environment or 'SATCE' (pronounced 'sat-see') is an emerging AI-based training technology for flight simulators, equally applicable to military, civil, fixed-wing and rotary-wing pilot training. It automates ATC and other traffic simulation to complete the simulation of the environment outside the cockpit. Scenario-based training is greatly enhanced by a higher fidelity synthetic environment, providing flight crews with realistic workloads and instructors with increased capacity to observe and train, no longer having to role play ATC. Across the global flight training industry, organisations are starting to integrate SATCE into their pilot training programmes and flight training devices. This paper provides perspectives from experience of using SATCE in European trials and evaluations. Observations validate initial assumptions regarding the positive impact that SATCE has on the flight crew in training and the potential for significant added training value.

1 Overview

This paper has associated video material that demonstrates Simulated ATC Environment (SATCE) technology, showing it in use in both a high-fidelity fixed-base and a full motion Level D Full Flight Simulator (FFS) for both civil ab initio and airline scenario-based training sessions.

Observations validate initial assumptions about the impact of SATCE, most noticeably in delivering realistic, increased flight crew workloads. The opportunity to exercise Situational Awareness (SA) is supported by the presence of other traffic, as is Threat and Error Management (TEM). During trials and evaluations, SATCE has also been observed to increase the flexible use of training devices.

2 Introduction

SATCE (pronounced 'sat-see'), has been a long time coming. It is now in training. Across both civil and military flight training industries, innovative training organisations are starting to implement this emerging training technology for their pilot training programmes and training devices.

This paper provides perspectives from experience of using SATCE in European trials and evaluations in civil fixed-wing flight training devices, although this technology is equally applicable for rotary-wing, military and Remotely Piloted Aircraft Systems (RPAS) flight simulators. Examples are presented from an ab initio trial using a fixed-base high-fidelity training device and from an evaluation using a Level D FFS.

2.1 What is SATCE?

SATCE introduces automated ATC services and other traffic entities in to Flight Simulation Training Devices (FSTDs). Combined with an out-the-window visual system and weather simulation, SATCE 'completes' the synthetic environment simulation with the addition of automated ATC and realistic other traffic.

As part of a draft update to ARINC Specification 439A, see Ref. [2], the FSEMC SATCE Working Group has succinctly defined SATCE as "a synthetic environment in which air traffic control services and other traffic entities are simulated".

A busy virtual traffic environment and fully automated synthetic ATC services offers instructors new training tools, and a flight crew experience that is significantly closer to real-world operations.

2.2 SATCE Training Benefits

SATCE is an emerging AI-based technology that is set to enhance synthetic flight training considerably. The training technology is applicable across all flight simulation training devices (FSTDs) and recommended by industry guidance for a wide range of pilot training. SATCE is most suited supporting real-time, scenario-based Line-Oriented Simulation (LOS) over manoeuvre-based training elements.

While SATCE is appropriate for both civil and military flight training, it is arguably most applicable in military flight training for transport category aircraft flight crews who operate increasing hours in civil airspace, and also for disaster-relief type operations.

SATCE offers these benefits:

- Supports the increasing adoption of real-time scenario-based training (LOS).
- Supports competency-based training approaches and programmes such as the Multi-crew Pilot Licence (MPL) and Evidence-Based Training (EBT).
- Other traffic simulation supports the introduction of new Air Traffic Management (ATM) procedures associated with the FAA's NextGen and EASA's SESAR programmes.
- Training for new aircraft technologies, such as ADSB-IN and Data Link communications can be supported in a simulated traffic and communications environment respectively.

- Existing training elements, such as TCAS, missed approach procedures (MAP), the threat from runway incursions and wake turbulence training can all be enhanced by the presence of active moving other traffic in the simulated environment.
- Offers increased workload for the flight crew in training, especially in busy traffic ground and airspace environments. Realistic ATC communications, that reflect operational levels of complexity, such as conditional clearances, adds to the cockpit workload, as does consideration of other traffic threats and movements.
- Full automation of the ATC function reduces instructor role-play and frees them better to observe and train the flight crew.
- Supports the adoption and use of ICAO Standard Phraseology for radio communications and exercises the use of English language in simulator training for non-native English speakers.
- For military pilot training, SATCE could offload some live aircraft training currently performed by air forces in to more effective synthetic training, which could offer efficiency savings and a reduction in environmental impact.
- Supports Remotely Piloted Aircraft System (RPAS) pilot training by providing a populated synthetic environment with realistic ATC services. SATCE may be particularly useful technology to support mixed military / civil and manned / unmanned ground and airspace pilot training.

However, as with the introduction of any new technology, the adoption of SATCE introduces some associated challenges:

- Although proven, SATCE requires integration with multiple flight simulator subsystems, including the FSTD visual, host and communications systems. This presents some barrier-to-entry for fielded devices, although this may be mitigated if integration is carried out during planned updates and upgrades.
- New data associated with ATC procedures, phraseology and other traffic is necessary to keep up-to-date, especially in qualified devices where regular updates are mandated to maintain currency with real-world navigation and environment data.
- Adaptation and redesign of training programmes is necessary to incorporate new challenges and threats made available by introducing SATCE.

2.3 Is SATCE required?

SATCE is not yet required for FSTDs, except by the European Aviation Safety Agency (EASA) for a particular licence. Once widely established and proven in training, it is expected that SATCE will become an essential mandatory component of synthetic flight training programmes and also included within the formal specification, qualification and evaluation of FSTDs.

EASA currently requires the use of ‘ATC Simulation’ for flight training devices used for the Multi-crew Pilot Licence (MPL). This was introduced by EASA in 2011, in response to the increasing use of FSTDs in ab initio training programmes, and reduced exposure of cadets to real-world operational complexity, especially in terms of the communications and traffic environment.

In summary, industry guidance concerning SATCE is maturing, with SATCE recommended in guidance material from the ICAO, see Ref. [1], ARINC see Ref. [2], and IATA see Ref. [3]. Guidance material has been developed by industry experts from a wide range of disciplines from flight training and flight simulation over several years, facilitated by the FSEMC as part of ARINC Industry Activities (an SAE ITC Program).

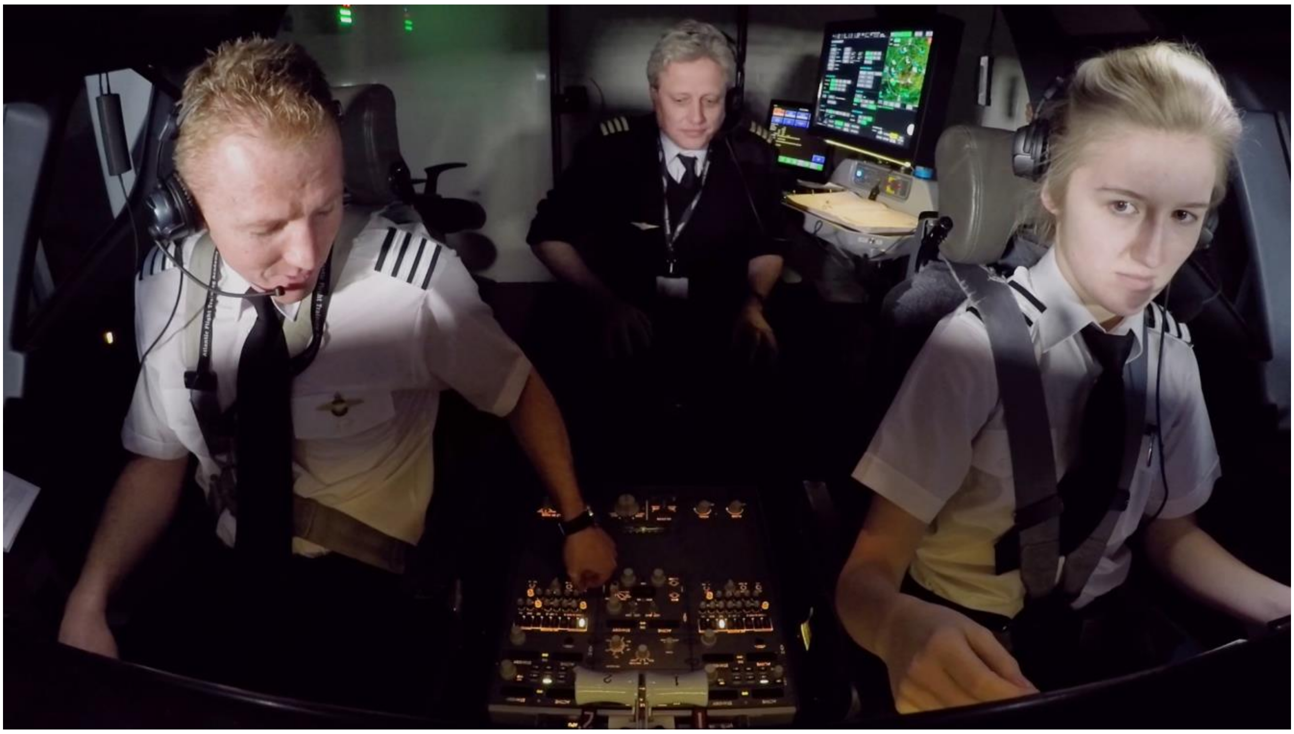

Fig. 1. SATCE in training in European trials. Full and disciplined use of radio communications with multiple automated ATC services is required during scenario-based training while the instructor is free to observe and train the flight crew without role-playing ATC.

3 European trials

Quadrant Group has partnered with Multi Pilot Simulations (MPS) in The Netherlands and Atlantic Flight Training Academy (AFTA) in Ireland to run a pioneering trial of its real-time, dynamic, and interactive SATCE solution integrated in to a high-fidelity fixed-based Boeing 737 simulator, see Fig. 1. The simulator is located close to Cork International Airport and used for a variety of ab initio pilot training including MCC and APS-MCC.

The Group has also integrated its SATCE solution in to an Airbus 320 Level D FFS, located at Quadrant's own flight training centre in Burgess Hill, UK, near London Gatwick airport. This simulator, originally manufactured by CAE, is used for a variety of flight training, see Fig. 2. The image generation system used for evaluating SATCE is a Collins Aerospace EP-8100, which has the capacity necessary to display multiple moving other traffic models simultaneously, generated and stimulated from Quadrant's SATCE solution INTERACT.

4 Observations

4.1 Increased crew workload

Flight crew workloads have been observed to have increased, especially for the pilot monitoring and responsible for radio communications. The responsibility of having to operate radio functions and constantly filter a busy radio traffic environment for the ownship callsign has added a realistic level of increased workload. The exercise of workload management and appropriate crew resource management (CRM) are necessary as a result.

Internal cockpit communications are more realistic as a result of the SATCE automatically simulating radio communications between ATC and other traffic. A busy radio environment, particularly during taxi manoeuvres, is frequently disruptive to communications between flight the crew. This level of fidelity is nearly impossible, where the instructor is role-playing ATC.

4.2 Situational Awareness (SA)

Other traffic are simulated in out-the-window and on cockpit navigation displays, providing a correlated picture of the traffic environment to the flight crew. Where training scenarios include other traffic both ahead and behind the ownship, this provides the flight crew with context supporting SA. For example, a traffic departing in front of the ownship will give an awareness of the kind of weather the ownship might expect, as this information is included in clearances and instructions from ATC.

4.3 Threat & Error Management (TEM)

In a busy traffic scenario, other traffic movements may require flight crew consideration, increasing their cognitive workload. Other traffic using the same taxiways, runways and airways as the ownship may require the flight crew to take it in to consideration. At a minimum, the ownship flight crew need to be aware of other traffic movements, especially during ground manoeuvres where traffic is in close proximity.

For example, ATC may require the ownship to give way to another traffic or may issue an ownship clearance that is conditional on another traffic movement. Other traffic may also become a threat to the ownship, and this would require the flight crew exercise TEM.

4.4 Training flexibility

SATCE has been observed useful for supporting in-seat instruction, where the instructor is relieved of the task of role-playing both a flight crew member and all ATC services. This benefit of SATCE may increase the flexible use of FSTDs in the future. With SATCE, the training experience is closer to real-world, facilitating realistic cockpit workflow and communications now that the instructor is not having to role-play ATC while instructing ‘in-seat’.

4.5 Training dynamics

External threats and challenges to the flight crew that used to originate directly from the instructor, now have an ‘apparent’ external origin – they appear to come from the external environment. This has been observed to subtly change dynamics inside the simulator from one that may have previously been adversarial to one that is more co-operative - where the instructor is seen as able to assist the crew, where appropriate, to tackle external environment threats, such as a challenging or late clearance from ATC.

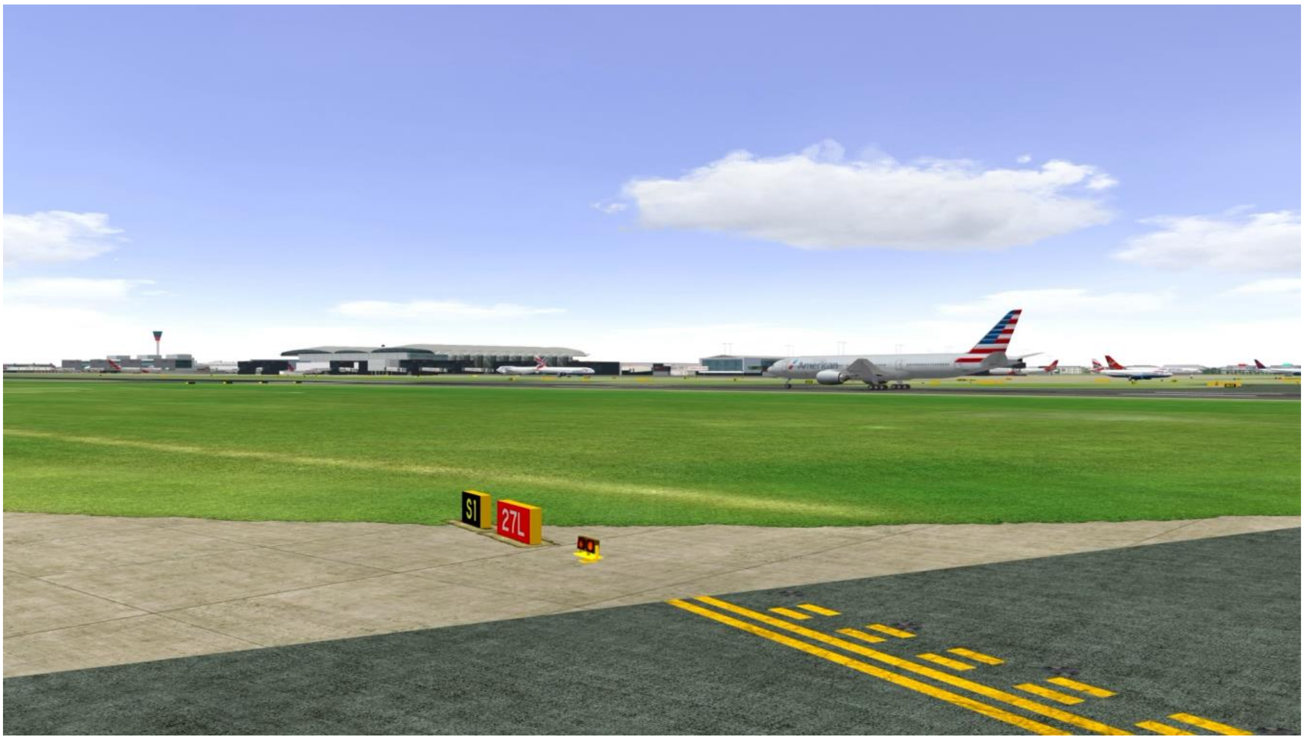

Fig. 2. Other traffic simulation, using Quadrant's SATCE solution INTERACT captured using Collins Aerospace EP-8100 image generation system. This capture shows other traffic departing ahead of the ownship from Runway 27L, London Heathrow.

5 Future work

Observations from trials and evaluation of SATCE technology by Quadrant Group validate initial assumptions regarding the positive impact on the flight crew and potential for significant added training value during scenario-based synthetic flight training.

Additional work seeking to widen evaluation of this emerging training technology beyond Europe and in partnership with airlines, air forces, training organisations, academic and national aviation authorities is ongoing. Further industry activity concerning SATCE, should help to further validate the initial observations in this paper, and also help to direct future development, guidance material and future regulatory requirements.

Speaker Biography

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Jeremy is the Product Lead for Simulated ATC Environment (SATCE) for Quadrant Group. He is also the Industry Editor for the FSEMC Working Group on SATCE that has published ARINC Specification 439A. As a member of the International Pilot Training Association (IPTA) he has contributed to ICAO Document 9625 on SATCE, as well as guidance material in IATA and IFALPA publications. Since 2009, Dr Goodman has helped lead Quadrant Group's development of a fully automated, dynamic and interactive SATCE solution. Jeremy has presented widely on SATCE, including at international pilot training and engineering conferences and at various industry meetings including WATS, EATS, APATS, The Royal Aeronautical Society (RAeS), FSEMC, EFTeG, and STIG.

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