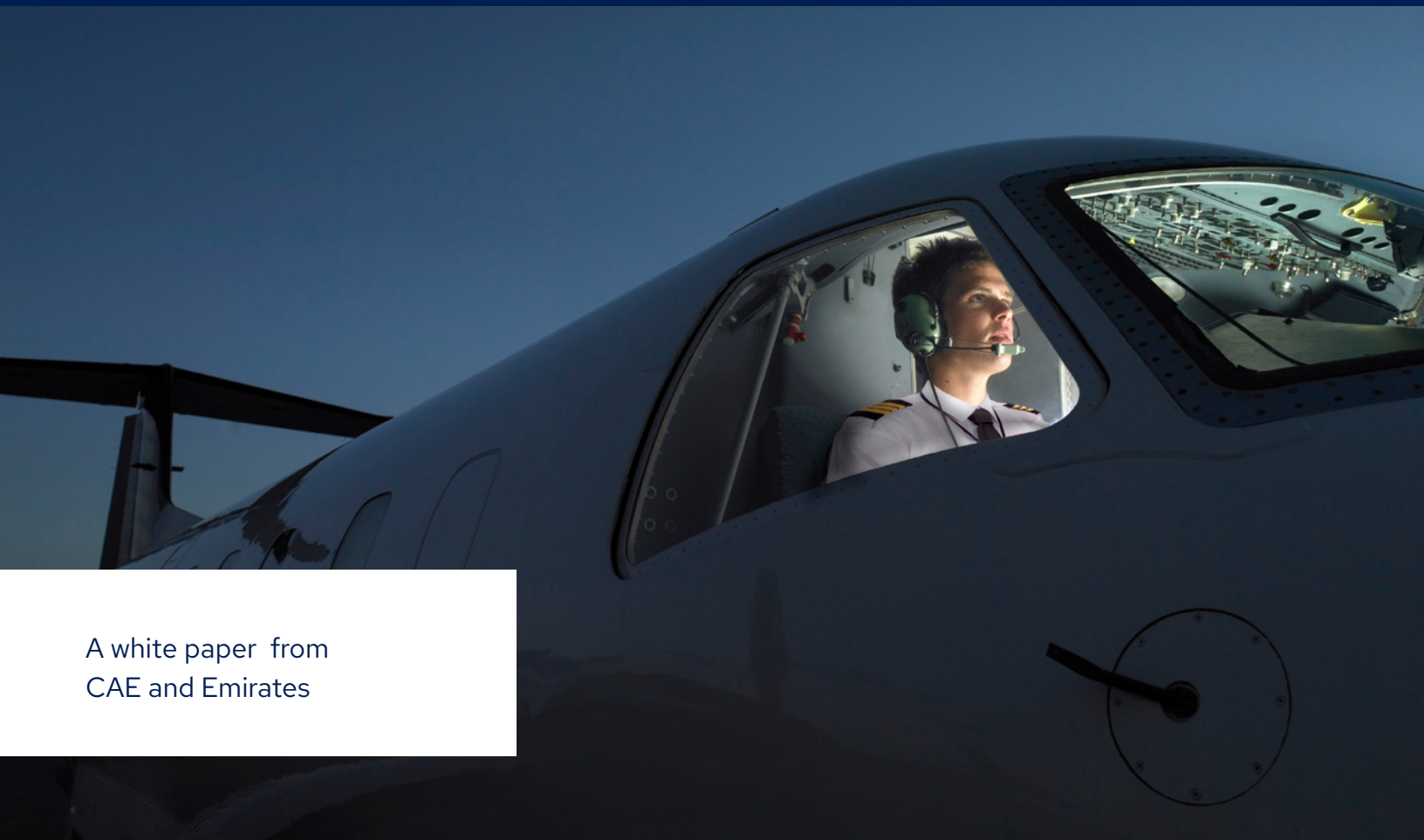
AVIATION TRAINING

Simulation for Experiential Training (SET) – Evolution and Expansion



A white paper from
CAE and Emirates

Table of contents

Authors

Captain Mark Cameron
Former A380 Pilot/CRMI at Emirates

Dr. Nicklas Dahlstrom
Human Factors Manager at Emirates

Dr Richard J. Kennedy
Head of Learning Science at CAE

Background

The ways in which pilots train in the future will look very different to the ways in which they train today. This paper builds upon the thoughts presented in the previous White Papers from CAE-Emirates on the future learning ecosystem for pilot training framework which outlined the main ideas and concepts to enable for the pilot training of tomorrow.

This paper is the fifth and last in the series on Simulation for Experiential Training (SET) and is a follow up to the previous four papers - Dahlstrom and Kennedy (2022), Dahlstrom et al (2022), Cameron et al (2022) and Cameron et al (2023). These papers outlined a vision of a modular training system effectively using different types of training material combined with elements of Artificial Intelligence (AI) with specific focus on Simulation for Experiential Training (SET) as the key component of this system. SET has been highlighted as a new and innovative component that could increase engagement and provide more effective learning, especially in the light of an eroding experience base in the aviation industry.

SET was originally developed and implemented for the training of Emirates pilots in two Recurrent training cycles from 2018 to 2020. In both cases, the complete group of 4000+ pilots at Emirates. Data and feedback from both cycles was collected and analysed. SET was also deployed for Initial and Command training at Emirates.

In short, the feedback was conclusively positive and the data, as well as instructor observations from instructors delivering the training, pointed not only to the training value but also to the potential for data collection and observation of pilot performance. The aim was to validate the training value as well as to further explore how data from the simulation can be collected and used.

For a viable commercial product there is work remaining, in the form of developing supporting documentation to support the trainer and trainee. It is especially important that briefing and debriefing material and methods are developed to ensure that full training value of the simulation is extracted in any given session. Also, data collection methods and analytics, including automated feedback, needs to be developed. Finally, it is necessary to build up not only a set of different simulation scenarios, but a repository of them to provide the breadth and depth of the training experience. This last area, namely developing a "Scenario Bank", is the main focus of this paper.

Therefore, this paper presents some overall ideas on how further development can be planned to move SET from a few scenarios, to a broad suite of training tools that supports the cost-effective development of pilot competence in the industry, as well as realising the commercial potential of this product.

Simulation for Experiential Training (SET)

Since its deployment in 2018, the priority for the evolution of Simulation for Experiential Training (SET) has been to develop the generic aircraft model that underpins it. The second priority has been to develop additional scenarios to continue trials with the training method to deliver this training as well as to work on data collection and analysis. However, in parallel to the aforementioned two priorities, planning needs to be made for the expansion of SET, i.e., how to scale the simulation as a training tool so that it can be used widely in the industry. This expansion will have to be focused on building a collection of scenarios that represent the set of different situations for which SET can provide the best possible training value.

As described in Reference 3, the first SET scenario was based on a fuel leak event and the second was based on fuel contamination. Various other scenario ideas have been drafted, including technical problems, medical diversions, weather situations, volcanic ash encounters or a combination of events that can lead to measuring the dynamic decision making and risk assessments that pilots must take during operations. The data capture feature of SET is a valuable function that can generate behavioural evidence which reflects actual "work as done" on the line. This data can also be iteratively fed back into the scenario generation within the SET philosophy.

One of the main benefits of SET is that it can provide training in preparation and support of Full Flight Simulator (FFS) training, but another one is that unusual and unexpected scenarios that may rarely or never make it into the simulator due to other priorities can be practised with SET. This means that SET can enhance the depth of learning by supporting other training methods as well as provide training of rare scenarios that cannot be motivated when airlines are confronted with limited training resources. Inevitably, any operator has to establish priorities in favour of "normal" day-to-day operational situations versus rare but potentially catastrophic scenarios (e.g. glide slope intercept from above vs. volcanic ash).

Developing scenarios is challenging and too often underestimated in the industry. While training technology in the form of simulation has seen great development, the understanding of scenario design seems to be at best incoherent across the industry. Valuable lessons were derived from the development of the first SET scenarios. One was that the scenario design should include signals or triggers of different strength, as this provides data on trainee monitoring and Situation Awareness. For the fuel leak scenario, which was modelled on the Air Transat 236 fuel leak in 2001, the first prompt was a low oil temperature, a subtle signal (and unusual – since impending trouble is usually indicated by an increasing oil temperature), but one that was the focus of attention and analysis of some trainees. The next signal was the increased fuel flow in the engine with the leak, a far more noticeable trigger and one noticed by most of the trainees. Finally, a system message about the lack of adequate fuel to reach destination was generated to prompt those who missed the previous signal to move on to the next stage in the scenario. Although this may be seen as an obvious design feature by experienced trainers involved in scenario design, we have been surprised of how much of the industry's thinking with regards to scenario design, stops at the nature of the technical events to use and how little thinking there seems to be to consider other design aspects, especially ones related to Human Factors. This tendency may be compounded by the current philosophy of "clustering" of events into groups of similar difficulty.

Another aspect of scenario design that has come up in development discussions is the use of concurrent tasks to force shifting of priorities at different workload levels. One example is the inclusion of tasks that cannot be resolved immediately but should be "parked" and returned to later. Another one is inclusion of decision situations which are under-specified: These are designed to force the pilots to conduct their own analysis, rather than have the support of a procedure to execute. Designing in technical consequences that may rarely occur in normal operations offer another potential for in-depth technical learning via scenarios. Also, designing in challenges of different levels of technical detail can be used to force pilots to shift between strategic thinking and technical or procedural accuracy (which is difficult, since pilots can get fixated on procedural and technical detail). These are just examples of design thinking prompted by working with SET, however, what this demonstrates is that using lower level of simulation fidelity will force more advanced scenario design. This advanced design can also benefit training in simulators with higher fidelity as postulated in Reference 1): "SET is not only a cost-effective way of delivering training, at times a lower level of simulation provides more effective training than a Full Flight Simulator as it focuses better on specific competences and removes some distracting realistic features".

Establishing a Simulation for Experiential Training Collaborative

One way to expedite the expansion of available SET scenarios would be to offer the simulation platform and scenarios for free, or at a limited price, to a few selected partner airlines. In return, these partner airlines would commit to developing a small number of scenarios, for example, three to five. This would allow the "SET Collaborative" to build-up a large scenario simulation bank in a relatively short period of time, which could then be offered to the rest of the industry under a subscription service. Such a solution could also lead to a "developer's community" with the few selected partner airlines.

An initiative such as this would lead to the possibility to host up to fifty scenarios (ten partner airlines, each developing five scenarios) on a web-based training platform. Access to this could be provided by airlines or training organisations buying credits for scenario access. The scenarios would come with trainer and trainee instructions, data and automated feedback and recording of training performance, including recommendations of other scenarios for building competence. Properly managed SET training data would also provide a broader view on operational challenges that confront the whole business as an additional source of information for the collective Safety Management System.

One great benefit with developing SET to scale with a web-based solution in a short time would be the amount of data produced by trainees. This would provide insights to pilot performance that in turn generates new training needs and thus new scenarios. The argument could then be made that this type of data identifies specific focus for improvements (e.g., monitoring and workload management for pilots with less than 3000 hours) and existing scenarios could be recommended for those pilots or new ones could be developed.

The potential problems with this solution may be finding committed partner airlines, coordinating scenario development, and ensure that the scenarios are not over-specified for the respective partner airlines.

Simulation for Experiential Training and Artificial Intelligence

With SET, there is great potential to capture data that reflects actual pilot performance, and this would be combined with the use of analytics on that data. Pilots who repeatedly miss minor signals and early triggers in the scenarios would get custom-made feedback and recommendations on what other scenarios they could use to train the competences of monitoring. Decision making where all information was not explored (as indicated by choices made by interaction with the interface) would get specific feedback on decision making processes.

Overall, this would be a low-cost version of data collection, similar to what is known as SOQA (Simulator Operational Quality Assurance), but more basic, given the limitation of the amount of data and the design option to focus on certain competencies in scenarios. The possibility of fully exploiting the use of data from SET has not been fully explored but, in the context of the overall training system, it has significant potential.

A Vision for SET
Full Implementation at Scale

Fully implemented at scale, SET would be integrated into the training system so that the full range of pilots from cadet to senior captain, would have practical and simple training available to them covering diverse scenarios at varying levels of difficulty. New pilots in an airline would receive relatively simple scenarios with procedural focus (e.g. a cabin smoke scenario where they would decide who to contact and in which, workload and situation awareness are the focus). To develop First Officers towards command, increasingly advanced and unusual scenarios can be used (e.g. to develop their decision making skills under uncertainty). On a Command Course more "out-of-the box" scenarios where there is high workload, uncertainty and under-specification of information would test and prepare the candidates for the kind of "to the limit" training in the Full Flight Simulator (FFS) that would provide confidence for extreme situations. Importantly, in these situations, since SET is a "safe to fail" activity, pilots would be more willing to experiment with alternative management strategies.

Summary and conclusions

This paper has considered how Simulation for Experiential Training (SET) can be further evolved and expanded within the future learning ecosystem for pilot training. SET will not replace existing training technology but instead will help prepare pilots for the Full Flight Simulator (FFS) and in some cases complement and enhance training in the FFS.

The greatest potential for SET however is through its role as an engaging and interactive learning experience. SET sits between the broadcast of information (via classroom or computer) and the full immersion in the FFS. In a time of increasing cost pressure on training compounded by an eroding experience base in the pilot population SET should offer an attractive proposition to the industry and truly help move training forward into the 21st Century.

References

1. Dahlstrom, N. and Kennedy, R.J. (2022) A future learning ecosystem for pilot training: A white paper from CAE and Emirates airlines. https://www.airside.aero/magazine/articles/a-future-learning-ecosystem-for-pilot-training

2. Dahlstrom, N., Cameron, M. and Kennedy, R.J. (2022) Simulation for Experiential Training as an enabler for Evidence-Based Training: A white paper from CAE and Emirates airlines. https://www.airside.aero/magazine/articles/simulation-for-experiential-training-as-an-enabler-for-evidence-based-training

3. Cameron, M., Dahlstrom, N. and Kennedy, R.J. (2022) Competency Scoring in Simulation for Experiential Training (SET): A white paper from CAE and Emirates airlines. https://www.airside.aero/magazine/articles/competency-scoring-in-simulation-for-experiential-training

4. Cameron, M., Dahlstrom, N. and Kennedy, R.J. (2023) Embedded Training and Simulation for Experiential Training (SET): A white paper from CAE and Emirates Airlines. https://www.airside.aero/magazine/articles/embedded-training-and-simulation-for-experiential-training

5. Cameron, M. and Kennedy, R.J. (2018) Mid Fidelity Simulation: Expanding Experience into Expertise. Presented at Flight Safety Foundation (FSF) International Air Safety Summit (IASS). November 12 – 14, Seattle (USA).

About CAE

CAE is a high technology company, at the leading edge of digital immersion, providing solutions to make the world a safer place. Backed by a record of more than 70 years of industry firsts, we continue to reimagine the customer experience and revolutionize training and operational support solutions in civil aviation, defence and security, and healthcare. We are the partner of choice to customers worldwide who operate in complex, high-stakes and largely regulated environments, where successful outcomes are critical. Testament to our customers' ongoing needs for our solutions, over 60 percent of CAE's revenue is recurring in nature. We have the broadest global presence in our industry, with approximately 10,000 employees, 160 sites and training locations in over 35 countries.

www.cae.com

About Emirates

The Emirates story started in 1985 when the airline launched operations with just two aircraft. Today, it operates the world's biggest fleets of Airbus A380s and Boeing 777s, offering its customers the comforts of the latest and most efficient wide-body aircraft in the skies. Emirates inspires travellers around the world with its global network of destinations across six continents, industry leading inflight entertainment, regionally-inspired cuisine, and world-class service.

www.emirates.com