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AUGMENTING ROYAL CANADIAN AIR FORCE SIMULATION WITH COMPLEMENTARY INSTRUCTIONAL TECHNOLOGY

Major Corey Taylor

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AIM

1. This paper aims to identify areas for further investigation within the Royal Canadian Air Force (RCAF) to leverage technological advances to optimize training, in conjunction with the use of simulation. These areas are distance learning, applying video game design to instructional design, improving training management systems and applying data analysis to training development.

2. While this paper will deal primarily with training of RCAF aircrew members, the technology and improvements to training methodology can be applied to any occupation that uses simulation in its training.

INTRODUCTION

3. In 2015, the RCAF Simulation Strategy 2025 (RSS) was released, marking the RCAF's full commitment to using simulation where applicable in lieu of actual aircraft.[1] The RCAF has already realized benefits of simulation such as: savings on fuel and airframe hours; ability to tailor training scenarios regardless of weather or other external factors; and reducing unavailability of airframes due to competing priorities and cancellations due to unserviceabilities, yet the optimization of simulation as a training multiplier is arguably still in its infancy.

4. The release of the RSS was intended to "further refine the Air Force's use of simulation."[2] Then Commander of the RCAF, LGen Blondin, stated, "I believe we can

[1] Canada. RCAF Simulation Strategy 2025 Executive Summary http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=executive-summary-rcaf-simulation-strategy-2025/i6mj0r6z, 12 March 2015
[2] Sonia Dumouchel-Connock "Aurora Aircraft Crews Use Simulation to Rehearse for Future Missions," Royal Canadian Air Force, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=aurora-aircraft-crews-use-simulation-to-rehearse-for-future-missions/huwd2rdd

achieve better training through simulation and achieve operational savings. In doing so, we can extend the life of our aircraft, and, at the same time, reduce our carbon footprint."[3] Many agreed that simulators "offer the RCAF less expensive ways of training and maintaining the skills of its air crews,"[4] resulting in "less wear and tear on aircraft, thus allowing the RCAF to extend the life expectancy of aircraft and reduce overall per year costs of each aircraft."[5]

5. Much of the focus of the RSS, aside from the cost savings of operating simulators instead of aircraft, was on interconnectivity and common training across fleets. Discussions ensued on design of synthetic environments, with the goal of platforms and communities collaborating on building simulated training environments and "networking these worlds together."[6] This has already begun to be implemented with varying degrees of success within RCAF fleets, such as the CP-140 community, as highlighted in their participation in networked simulation exercises[7], and their use of simulation to prepare for specific deployments, such as the overland Intelligence, Surveillance and Reconnaissance role it conducted at Operation IMPACT.[8] However, the goal of a fully integrated, optimized training system that mixes live, virtual and constructive training at the right time, at the right place, to "deliver what we need in the most effective and

[3] Ryan Kastrukoff, *Shifting Paradigms: Aerospace Simulation in the RCAF* (RCAF Journal - WINTER 2015 - Volume 4, Issue 1), accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/cf-aerospace-warfare-centre/elibrary/journal/2015-vol4-iss1-09-shifting-paradigm.page
[4] Connock, Sonia, "Embracing the Future: RCAF Finds Solutions in Innovative Training Technologies," Royal Canadian Air Force, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=embracing-the-future-rcaf-finds-solutions-in-innovative-training-technologies/ht8s3wor
[5] Connock
[6] Kastrukoff
[7] Dumouchel-Connock
[8] Carey Fredericks, Operation Impact: Aurora crews benefit from SIM training – *Wings Magazine* Jan. 12, 2015, Ottawa https://www.wingsmagazine.com/operation-impact-aurora-crews-benefit-from-sim-training-11466/

efficient manner possible,"[9] using a common virtual training environment is yet to be fully realized.

6. RSS looks to 2025 and beyond and therefore still has time to meet its aims, such as "augmenting the training system by addressing any requirements for new training devices that result from the detailed training needs analyses."[10] This long-term goal, however, only seems to account for the acquisition of simulators and new training devices. There are other factors and technologies which will be outlined in the pages that follow that should be examined in order to achieve optimum training outcomes.

DISCUSSION

Training Development Approaches

7. In adopting simulators, regardless of quality or fidelity, trainers must be cautious of importing training inefficiencies from the airborne to the synthetic environment. According to Salas et al (writing in 1998, but whose insights into the then-burgeoning world of simulation for pilot training still ring true), "the very large majority of training funding is allocated to the development of simulation devices and not to further our understanding of the learning process… the "human" side of training research has simply not kept pace with the "machine" side.[11] They also wrote that "simulation is being used without consideration of what has been learned about individual and team training and cognition."[12] The need to use technology to promote learning and design "human-

[9] Connock
[10] Government of Canada, Royal Canadian Air Force Simulation Strategy 2025, website, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=executive-summary-rcaf-simulation-strategy-2025/i6mj0r6z
[11] Eduardo Salas, Clint A. Bowers, and Lori Rhodenizer, "It Is Not How Much You Have but How You Use It: Toward a Rational Use of Simulation to Support Aviation Training," *International Journal of Aviation Psychology* 8, no. 3 (1998): 199. http://nas.psych.uidaho.edu/~ad.uidaho.edu%5Cbdyre/psyc562/readings/VE_Simulation_Motion_Sickness/Salas_etal(1998).pdf
[12] Ibid

centred training systems that support the acquisition of complex skills," has arguably not been prioritized over designing "simulation for realism (and hope that learning occurs)"[13]

8. Perhaps there is a role in this regard for the CAF's Training Development Officers (TDO). This occupation is highly trained in instructional design, but are perceived as experts on updating training documentation, but not directly influencing training programme development. Refocusing TDOs to have a role in higher-level acquisition and implementation of new training technology, using their backgrounds in human factors and psychology, would optimize use of training technology. RCAF courses typically consist of having a group of students on a course who must each meet certain objectives at the same time before all proceed to the next level and there remains a mindset where every step in a training programme needs to be rigorously adhered to. Since students learn at different rates, tailored delivery of material at the right pace for each student would be a better approach, as recently noted at 15 Wing Moose Jaw.[14] More rigorous investigation into how students learn, and direct application of the lessons to instructional design, would yield significant benefits.

Application of Video Game Design to Instructional Design

9. It is logical to investigate other areas, beyond sequencing, for optimizing learning. Video game research is showing potential benefits for learning specific skills and improving cognitive functioning.[15] Harnessing elements that make video games so engaging presents a major opportunity for optimizing instructional design.

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[13] Ibid
[14] Chris Thatcher, "Next Gen Aircrew Training" *SKIES Magazine* accessed October 28, 2019, https://www.skiesmag.com/features/future-aircrew-training-program-next-gen-aircrew-training/
[15] David Orenstein, "Score! Video gamers may learn visual tasks more quickly," Brown University Website, accessed 28 October 2019, https://news.brown.edu/articles/2015/03/gamers

10. Like RCAF training, video games are linear, in that one "proceeds along a task, then a sub-task" while applying "singular focus"[16] and both rely on a "building block approach," which emphasizes progresses from easier tasks to more complex ones, although video games arguably focus more on this principle. Unlike structured learning, players can fail through experimenting or trying new things. Our training, conducted in a pass/fail manner, denies this opportunity for learning. In the RCAF, students may have relatively few opportunities to practice a task before being assessed on a pass/fail basis. With the video game, there is a much larger potential for repetition to master the task to the required level (beating a level or stage of a game).

11. Game designers also focus on balancing challenge and skill and on incremental successes. At each stage of a video game, the levels are slightly harder than the player's skill level, which taps in to the player's motivation and encourages them to do "just a little bit better" to get to the next level. While it could be argued that this aspect is already captured in RCAF training, video game designers integrate continual encouragement through small successes more effectively than RCAF training designers.

12. When a player is successful or makes a mistake in a video game, they receive instant feedback, whereas student who make mistakes do not if the instructor misses the error or if it is deemed too insignificant for instant feedback. This area, perhaps, has the strongest potential for application to training, particularly when combined with advanced simulators.

[16] Lane Wallace, Can Video Games Teach Us How to Succeed in the Real World? *The Atlantic,* accessed October 28, 2019, https://www.theatlantic.com/technology/archive/2010/12/can-video-games-teach-us-how-to-succeed-in-the-real-world/67942/

13. Research shows "people will work harder when they are closer to reaching a goal."[17] In RCAF training, the highest difficulty occurs toward the end of training. The stage at which trainees often "run out of chances" on a course is precisely where they are willing to work the hardest to pass. People play video games partly for the intrinsic reward that comes from solving problems and achieving goals.

14. This paper is not suggesting the RCAF contract out a video game to replace flight simulators. The design of training, however, could leverage principles from the design of video games to ensure that trainees progress at a rapid pace and through increasingly complex scenarios while maximizing engagement and, ultimately, learning.

Training Management Systems

15. The RSS laid out that training management would be conducted through the Training Information Management System (TIMS), available through the predecessor to the Defence Learning Network.[18] TIMS has not been widely adopted for mapping out training requirements and progress, but databases like UL Tools and DRMIS have, although neither is considered user-friendly or without drawbacks. These tools are essentially databases built to capture older training models, electronically replacing paper and rudimentary digital versions to improve "scheduling training events to preparing for ground school and simulator sessions, and from submitting training requests to viewing training records."[19] CAE, among others, touts "new cutting-edge digital

[17] John Spencer, "What Can Video Games Teach Us About Instructional Design?" website, accessed October 28, 2019, http://www.spencerauthor.com/video-games/

[18] Government of Canada, Royal Canadian Air Force Simulation Strategy 2025

[19] CAE Press Release – "CAE accelerates digital transformation to enhance business aircraft pilot training experience" https://www.cae.com/news-events/press-releases/cae-accelerates-digital-transformation-to-enhance-business-aircraft-pilot-training-experience/

solutions…currently being deployed to deliver a superior training experience for the business aircraft pilot training market."[20]

16. Further leveraging these systems by tailoring them to our needs, beyond scheduling and document storage tasks, for use as sources of data for in-depth analysis, is not often discussed, but is necessary in advancing the RCAF's optimization of training.

Data Analysis

17. A further benefit of simulators is their ability to record every input by pilots, either experienced or those undergoing training, in order to build large data sets. These could be used to set a baseline for control surface inputs for pilots, for example, against which maneuvers of student pilots could be compared to assess the standard. While these very minor inputs could be imperceptible to human instructors, computers could sense and provide immediate feedback to correct errors to improve performance. Using the simulators to measure would also ensure consistency across students, eliminating preferences in techniques and variation in evaluation by human instructors while maximizing the skills of student pilots. These data sets could be leveraged to create optimum training sequences, as guided by the video game design principles previously discussed. While training sequences are currently developed through trial and error, the approach of using "Big Data" could ensure maximum efficiency through the training progression. Harnessing computing power in this way could also identify which "building blocks" contribute most to student learning and which are redundant or ineffective.

[20] Ibid

18. Recently, the RCAF revised its pilot selection process "from a series of aptitude tests and hand-eye coordination simulators to a computer-based assessment purchased from the Royal Air Force" and saw a halving in its overall attrition rate "from about 15 per cent to six to eight per cent."[21] Further use of data to analyze effectiveness of training, ideally by a cadre of highly trained and empowered training experts leveraging advanced data analysis and training science principles, could further reduce the number of training failures at various stages of the training continuum and speed up training throughput across RCAF training.

Distance Learning / Self-Paced Model

19. Rather than completing all components of a task or logging a specified number of hours, some education systems are turning to a competency-based format, which "builds backwards from the necessary outcomes or competencies in a particular professional field."[22] The RCAF and CAF have used a Distance Learning (DL) model for several years, allowing students to conduct self-paced professional development courses. Many flight schools now allow remote access to courses and associated documentation, with noted "improvements in terms of productivity as the trainees reach the objective of the training faster when they work around practical exercises."[23] This also allows the benefit of students being able to review the courses at any time that is convenient. In an environment where the new generation of the RCAF have grown up being extremely familiar with tablets, smartphones and other technology, this may appeal to their learning

[21] Chris Thatcher, "Next Gen Aircrew Training" *SKIES Magazine* accessed October 28, 2019, https://www.skiesmag.com/features/future-aircrew-training-program-next-gen-aircrew-training/
[22] Scott Kinney, "Meeting the needs of contemporary students" *The Hill Blog,* accessed October 28, 2019, https://thehill.com/blogs/congress-blog/education/203980-meeting-the-needs-of-contemporary-students
[23] Oleg Volkov, "How to make aviation training smarter?" accessed October 28, 2019, https://www.aerotime.aero/oleg.volkov/15659-how-to-make-aviation-training-smarter

styles more than sitting in a classroom. Additionally, "as aerospace hardware becomes more advanced, the inevitable reduction in real systems available for training means that computer-based lessons…will become an essential tool."[24]

20. Having these tools available in the RCAF could further speed students' learning and prepare them ahead of time for valuable simulator and flight training serials. In one instance of adopting this sort of technology, a Virtual Reality based aerospace training program in the UK called the Avionics Training Facility (ATF) enabled reduction of course length from 13 to 9 weeks, with no downtime.[25] Furthermore, instead of having a whole class progress at the same rate, those who are ready, per the competency-based model, could progress ahead of their peers. Under current constructs, this is difficult to manage but leveraging the right technology could reduce wait times between and within training programs.

21. While historically militaries have been on the cutting edge of technology and commercial entities have been slower to adapt, in the realm of applying technology to training, the commercial side now seems to be ahead of the RCAF in many regards.

Future Aircrew Training (FAcT)

22. With its FAcT program, the RCAF is attempting to initiate a comprehensive and ambitious approach to leverage industry to deliver efficiencies in aircrew training. While it is not clear which of the aforementioned technologies, will be incorporated by the eventual winning contractor, according to Col Pete Saunders, director of Air Simulation and Training, the RCAF is seeking "a program adaptable to technological change as both

[24] Stone, Robert J.; Panfilov, Peter B.; Shukshunov, Valentin E. *Evolution of aerospace simulation: From immersive Virtual Reality to serious games*, https://ieeexplore.ieee.org/abstract/document/5966921
[25] Ibid

training systems and teaching methodologies evolve."[26] Winning bidders for the FAcT contract will likely leverage all available cutting-edge technology to win the contract and most efficiently deliver the training. The model chosen for aircrew may also serve as a model for other occupations within the RCAF as well as influence Navy and Army training, if proven successful.

CONCLUSION

23. Since the RCAF Simulation Strategy was released, we have seen the stand-up of the Directorate of Air Simulation and Training and have seen significant progress in the FAcT project, which will provide the flexibility to leverage industry to incorporate the latest technology and best practices to improve how students learn will certainly progress RCAF training, particularly for aircrew. Other factors, such as Training Development approaches, application of video game techniques to instructional design, improvement in training management systems and further use of data analysis to optimize training, should be pursued further to allow the RCAF to fully harness the true capabilities of current simulators and other future technology.

[26] Chris Thatcher, "Next Gen Aircrew Training" *SKIES Magazine* accessed October 28, 2019, https://www.skiesmag.com/features/future-aircrew-training-program-next-gen-aircrew-training/

BIBLIOGRAPHY

CAE, *CAE accelerates digital transformation to enhance business aircraft pilot training experience,* accessed October 28, 2019, https://www.cae.com/news-events/press-releases/cae-accelerates-digital-transformation-to-enhance-business-aircraft-pilot-training-experience/

Connock, Sonia, "Embracing the Future: RCAF Finds Solutions in Innovative Training Technologies," Royal Canadian Air Force, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=embracing-the-future-rcaf-finds-solutions-in-innovative-training-technologies/ht8s3wor

Dumouchel-Connock, Sonia, "Aurora Aircraft Crews Use Simulation to Rehearse for Future Missions," Royal Canadian Air Force, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=aurora-aircraft-crews-use-simulation-to-rehearse-for-future-missions/huwd2rdd

Fredericks, Carey, *Operation Impact: Aurora crews benefit from SIM training* – Wings Magazine Jan. 12, 2015, Ottawa https://www.wingsmagazine.com/operation-impact-aurora-crews-benefit-from-sim-training-11466/

Government of Canada, "Future Aircrew Training," accessed October 28, 2019, http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1269

Government of Canada, Royal Canadian Air Force Simulation Strategy 2025, website, accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=executive-summary-rcaf-simulation-strategy-2025/i6mj0r6z

Kastrukoff, Ryan, *Shifting Paradigms: Aerospace Simulation in the RCAF* (RCAF Journal - WINTER 2015 - Volume 4, Issue 1), accessed October 28, 2019, http://www.rcaf-arc.forces.gc.ca/en/cf-aerospace-warfare-centre/elibrary/journal/2015-vol4-iss1-09-shifting-paradigm.page

Keiver, Colin, "Line Operational Simulation: Towards Optimizing Human Performance in the Canadian Air Force," *The Curtis Papers: Canadian Aerospace and Joint Studies* vol. 1, book 1 (2013): 4. http://airforceapp.forces.gc.ca/CFAWC/eLibrary/pubs/The_Curtis_Papers-Vol1-Book1_e.pdf

Kinney, Scott, "Meeting the needs of contemporary students" *The Hill Blog,* accessed October 28, 2019, https://thehill.com/blogs/congress-blog/education/203980-meeting-the-needs-of-contemporary-students

Orenstein, David, "Score! Video gamers may learn visual tasks more quickly," Brown University Website, accessed 28 October 2019, https://news.brown.edu/articles/2015/03/gamers

Salas, Eduardo; Bowers, Clint A., and Rhodenizer, Lori, "It Is Not How Much You Have but How You Use It: Toward a Rational Use of Simulation to Support Aviation Training," *International Journal of Aviation Psychology* 8, no. 3 (1998): 199. accessed October 28, 2019, http://nas.psych.uidaho.edu/~ad.uidaho.edu%5Cbdyre/psyc562/readings/VE_Simulation_Motion_Sickness/Salas_etal(1998).pdf

Spencer, John, "What Can Video Games Teach Us About Instructional Design?" website, accessed October 28, 2019, http://www.spencerauthor.com/video-games/

Stone, Robert J.; Panfilov, Peter B.; Shukshunov, Valentin E. *Evolution of aerospace simulation: From immersive Virtual Reality to serious games*, https://ieeexplore.ieee.org/abstract/document/5966921

Thatcher, Chris, Next Gen Aircrew Training *SKIES Magazine* accessed October 28, 2019, https://www.skiesmag.com/features/future-aircrew-training-program-next-gen-aircrew-training/

Truss, Kelvin, "Canada's Air Synthetic Environment Centre: Enabling Force Transformation" *The Defence Management Journal*, issue 57 summer 2012, accessed October 28, 2019, www.defencemanagement.com

Volkov, Oleg, *How to make aviation training smarter?* accessed October 28, 2019, https://www.aerotime.aero/oleg.volkov/15659-how-to-make-aviation-training-smarter

Wallace, Lane, Can Video Games Teach Us How to Succeed in the Real World? *The Atlantic,* accessed October 28, 2019, https://www.theatlantic.com/technology/archive/2010/12/can-video-games-teach-us-how-to-succeed-in-the-real-world/67942/

Wings Magazine, *Lockheed Martin Canada and L3 MAS join forces for RCAF training competition*, accessed October 28, 2019, https://www.wingsmagazine.com/lockheed-martin-canada-and-l3-16023/