

A comparison of two training needs analyses to RCAF simulation strategy requirements

Joint Terminal Attack Controller as a test case

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Abstract

The Director of Air Simulation and Training has set an ambitious target of 2025 for developing a simulation-first training strategy for the Royal Canadian Air Force (RCAF). To meet that objective, training needs analysis methods must be applied to highlight current gaps in training with respect to simulation-based instruction and collective training in a synthetic environment. The training needs analysis components of the Canadian Forces Individual Training and Education System (CFITES) and the Mission Essential Competency (MEC) method were compared with respect to their ability to address client-identified gaps from the Simulation Strategy. Using those scales, expert raters provided their judgement on the compliance of each method to thirteen criteria in five categories: links with strategic guidance; simulation and media use, collective training, tools for trainee assessment, and usability. Both methods performed poorly against the criteria, however the CFITES method was judged as providing better tools for assessing trainee learning and improvements to training, while the MEC method was judged as providing better opportunities to develop operational readiness in the trainees. The failure to promote simulation-based options for training may be a result of a lack of top-down guidance with respect to such a strategy, or possibly a consequence of guiding subject matter experts who do not fully appreciate the potential of simulation-based training. The lack of collective training in the simulated environment might be a consequence of role definitions which do not *ab initio* include a concept of interdependence with other roles.

Significance to defence and security

This assessment examines how two current training analysis methods can be used and adapted to overcome shortcomings in current RCAF methods for analyzing training exercises, equipment and programs. These improvements can reduce the risks involved in the equipment acquisition and training process being pursued under the RCAF Simulation Strategy 2025.

Résumé

Le Directeur – Simulation et instruction (Air) s’est fixé l’objectif ambitieux d’élaborer une stratégie d’instruction axée principalement sur la simulation pour l’Aviation royale canadienne (ARC) d’ici 2025. Pour y parvenir, il faudra analyser les besoins en matière d’instruction afin de cerner les lacunes existantes relativement à l’instruction axée sur la simulation et l’instruction collective en environnement synthétique. Nous avons comparé la méthode d’analyse des besoins du Système d’instruction individuelle et d’éducation des Forces canadiennes (SIIEFC) et la méthode des compétences essentielles à la mission (CEM) en ce qui a trait à leur capacité de corriger les failles décelées par les clients dans la stratégie de simulation. À partir des données recueillies, des experts ont évalué la conformité de chaque méthode en se basant sur treize critères répartis dans cinq catégories, à savoir : les liens avec les directives stratégiques, l’application à la simulation et aux médias, l’instruction collective, les outils d’évaluation des stagiaires et la convivialité. En regard des critères utilisés, les deux méthodes se sont révélées peu efficaces; cependant, on a jugé que la méthode du SIIEFC offrait les meilleurs outils pour évaluer l’apprentissage des stagiaires et les améliorations apportées à l’instruction, tandis que la méthode CEM offre de meilleures occasions de développer la préparation opérationnelle des stagiaires. L’impopularité des solutions d’instruction axées sur la simulation est peut-être attribuable à l’absence de directives descendantes ou encore au fait que leur potentiel ne soit pas tout à fait reconnu par les experts en la matière. L’inexistence de l’instruction collective en environnement de simulation est peut-être une conséquence d’une définition des rôles qui ne prévoit pas *ab initio* une interdépendance avec d’autres rôles.

Importance pour la défense et la sécurité

Dans cette étude, nous avons examiné comment deux méthodes d’analyse de l’instruction courantes peuvent être employées et adaptées pour corriger les lacunes des méthodes qu’emploie l’ARC pour analyser ses exercices, son équipement et ses programmes d’instruction. Les améliorations apportées peuvent réduire les risques associés au processus d’acquisition d’équipement et d’instruction envisagé dans la Stratégie de simulation 2025 de l’ARC.

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1 Background and rationale

1.1 Background

The Royal Canadian Air Force Simulation Strategy 2025 (2014a) has set a target date of 2025 for full development of a simulation-based training system. Improvements in cost, training opportunities, safety, fleet service life and environmental impact are all cited as motivating factors for this objective. In particular, simulation training provides unique opportunities for collective training in joint and coalition contexts which would otherwise be prohibited by cost, safety or logistical factors.

To meet its goals for simulation-based training and distributed collective training proposed in the strategy, it suggests improved training and training needs analysis (TNA) methodologies may be required (2014a). Currently the Canadian Forces Individual Training and Education System (CFITES) and the Air Force Training and Education Management Systems (AFTEMS) provide guidance and structure for training analysis and development. Although CFITES is aimed at *individual* training both in name and purpose, it can be applied to collective training. CFITES is currently being amended and rebranded to specifically include a collective training focus (B. Decechi, personal communication, March 23, 2016). Still, existing purpose-designed TNA methods might provide efficiencies if adapted or incorporated within a re-visioned Canadian Forces training system. At the very least, comparison of CFITES to such an alternative will provide a better understanding of the relative and absolute success of CFITES in meeting the requirements stated in the strategy. One current alternative is the Mission Essential Competency^{SM1} (MEC), a formally structured method currently in use by the United States Air Force for development of air crews (Alliger, Beard, Bennett, Symons, & Colegrove, 2013). MEC is an appealing choice for comparing to CFITES because MEC is mature, well-defined, and is employed by the RCAF's American counterpart, the United States Air Force (USAF) for training analysis (Alliger et al., 2013; Symons, France, Bell, & Bennett, 2006).

As recently as 2012, CFITES was used to analyze and develop performance standards and training plans for the Forward Air Controller (FAC), Tactical Air Control Party (TACP) and Joint Terminal Attack Controller (JTAC) roles. In 2015, analysis was performed for the JTAC role using the MEC method by a coalition of subject matter experts (SMEs) and support personnel from Australia, Canada, New Zealand, United Kingdom and the United States of America. This provided an opportunity to compare the outputs of CFITES against a different method. The resultant analysis of Knowledge, Skills and Abilities (KSAs), tactics, techniques, procedures (TTPs) and interdependence with other personnel provided a basis of comparison of the two methodologies with respect to simulation and collective training needs concerns.

To make this comparison, training analyses of Forward Air Controllers / Joint Terminal Attack Controllers (FACs/JTACs) is used. Current terminology with the CAF is to use the term JTAC rather than FAC, and throughout the remainder of this document, the term JTAC is used. This report compares TNA documents developed for the JTAC under the CFITES and MEC methods.

¹ Air Combat Command (A3TO), the 711 HPW/RHA (AFRL), The Group for Organizational Effectiveness, Inc. & Aptima, Inc. are the joint owners of the service mark Mission Essential Competencies and MECs.

In addition to individual knowledge, skills and attitudes, the JTAC role by its very definition requires interactions among different levels of collective behaviour, from sections and detachments to formations and brigades, making it a good test case. Further, full participation in the role requires deployment and use of aircraft and munitions by multiple team members. These technologies are inherently costly and dangerous to use, so an improved understanding of how live JTAC training could be augmented, replaced or enhanced by simulator use will certainly be valuable.

This report is targeted at a broad audience including the Department of National Defence, Director General of Air Force Development, the Directorate of Air Simulation and Training, the Canadian Army Doctrine and Training Centre (CADTC), The Air Land Integration Cell (ALIC) and members of the Canadian Forces Training Establishment. The intention is to provide a means of direct comparison between overlapping elements of CFITES and MEC for those exploring improvements to training policy and methodology within the Canadian Forces.

1.2 Scope of this report

Empirical research into training needs analysis is very limited, as is the comparative assessment of competing models (Sennett, Wright, Pennie, & Traub, 2015). This evaluation assumes that important differences exist between the CFITES and MEC models and that each offers particular benefits and incurs certain costs. However, it is beyond the scope of the present work to perform an extensive or detailed comparison of the CFITES and MEC methods in their entirety.

The current report contains a structured evaluation of how CFITES and MEC each address specific, simulation-based training gaps for the role of Forward Air Controller / Joint Terminal Attack Controller. While there are many possible metrics for comparison, including ease of use, complexity, return on investment, etc., the present analysis is restricted to answering the question: How well does each method support simulation-based training as identified by the DAST RCAF simulation strategy?

Close Air Support (CAS) is one of the twelve Airpower Missions defined in the strategic guidance document *Air Force Vectors* (Royal Canadian Air Force, 2014). The RCAF Simulation Strategy stipulates that in order to meet a simulation-focused training objective, that training requirements be traceable to force structure which in turn should be traceable to strategic guidance. In this regard all Airpower Missions should be clearly represented in the strategy, nevertheless, CAS appears to be the only Airpower Mission to receive brief mention (by name) in the simulation strategy and its appendices. However, the analysis here is intended to explore CFITES and MEC TNA methodologies, not CAS specifically.

Each of the two systems generates many supporting doctrinal, policy and methodological documents, however the analysis here is restricted to examining the Qualification Standard (QS) and Training Plan (TP) documents for CFITES, and the Summary Report and Comprehensive Mission Needs Analysis and Determination (COMMAND) report for the MEC method, since these outputs are largely self-contained, are most closely similar between the two methods, and best address the requirements identified in the simulation strategy.

The overall analysis is based on the following documents:

- Identification of The Simulation-based Training Gap:
 - ♦ The Royal Canadian Air Force Simulation Strategy 2025 (Royal Canadian Air Force 2014a); and
 - ♦ Royal Canadian Air Force Simulation Strategy 2025 - Annexes B–D (Royal Canadian Air Force 2014b).
- Doctrinal Guidance with respect to learning objectives:
 - ♦ Air Force Vectors (Royal Canadian Air Force, 2014).
- TNA Outputs:
 - ♦ Qualification Standard Forward Air Controller (CFITES) (National Defence, 2012);
 - ♦ Training Plan Joint Terminal Attack Controller (CFITES) (National Defence, 2015b);
 - ♦ Coalition Joint Terminal Attack Controller (JTAC) Mission Essential Competencies Final Summary Report (MEC) (The Group for Organizational Effectiveness, 2015b); and
 - ♦ Comprehensive Mission Needs Analysis and Determination (COMMAND) worksheet (The Group for Organizational Effectiveness, 2015a).

CFITES and MEC are distinct approaches which differ along many dimensions (see Martin, Huffam, Dececchi, Kerry & Grant, (in press) for a more detailed analysis). However, they share key elements of *training needs analysis*, which incorporates task analysis, training gap analysis and training option analysis (Huddleston & Pike, 2009), although training option analysis here will only receive minimal consideration. The report will focus on these elements for the comparison of the two cases under evaluation.

1.3 Client-identified gaps

Following the RCAF Simulation Strategy, by 2025 training will be simulation-focused through live, virtual and constructive (LVC) modes of operation integrated in a networked, common synthetic environment. By contrasting the current capability with the end state required to meet strategic objectives, current areas of deficiency were systematically identified. While the analysis in the strategy report focused specifically on aircrews, the identified training gaps would be applicable to any simulation-based training of teams or collectives.

1.3.1 Simulation-focused training

The RCAF Simulation Strategy stipulates that simulation-focused training is “necessary to better develop and maintain the skills necessary for a world-class Air Force” (Royal Canadian Air Force 2014a, p. 34). The document states that the RCAF will not create a new system for simulation-focused training, but will adapt the existing CFITES process. (As a case in point, authors use an exact duplication of the CFITES process figure, but label it “Simulation-focused Training Process”.) The critical difference between the “regular” CFITES process and a simulation-focused

CFITES process is the application of an Interactive Multimedia Instruction (IMI) analysis to determine the appropriateness of varying levels of simulator complexity and fidelity for a given learning objective in order to develop both cognitive and motor skill capacities.

Simply, such a focus places an emphasis on training that uses simulation media. The governance guidelines stipulate that:

The RCAF must adopt a virtual-first training policy. Where a training method and media analysis finds that a training device is suitable for a particular training, task, the default choice will be to conduct training in that manner. Live training will continue, but will be focused on training tasks that are not suitable for simulation and final confirmation. (Royal Canadian Air Force 2014a).

An important benefit of simulation training is the capacity to conduct joint and collective exercises, which in a live environment are costly, complex, and potentially dangerous. Synthetic training environments have the capacity to improve access to distributed training events.

1.3.2 Collective training

Despite the potential benefits afforded to collective training by simulation-focused training, and the overall importance of training above the level of the individual, Collective Training (CT) is poorly defined in RCAF doctrine, although different levels of collective activity are recognized (Royal Canadian Air Force, 2014). The 1st Canadian Air Division Orders, Volume 5 offers the following explanation of CT:

Collective training is not IT&E. This training is designed to prepare teams, crews, units and other elements to work together effectively to perform assigned tasks. Joint, Combined, Tactical, Strategic and Operational Training are all examples of collective training (National Defence, 2015a, p. 2/15).

This definition by negation is a reiteration of the Air Force Training and Education Management System (AFTEMS) explanation. By contrast the Training for Land Operations document states that:

CT is the mechanism by which a commander takes a full complement of qualified soldiers—combined with time, resources, and applied TTPs—to produce competent, cohesive and disciplined organizations that are operationally deployable within realistic readiness timeframes. Collective Training for land operations will, as much as possible, be progressive and conducted in an all-arms environment, building upon individual knowledge and skills, While Individual Training and Professional Military Education are important to the acquisition of knowledge and skills in each Developmental Period, the experience gained by individuals during Collective Training events exposes soldiers to more complex concepts and conditions, providing the broad base of experience and exposure needed to progress to the next Developmental Period (National Defence, 2014, p. 6.1.1).

In comparison with the RCAF statement, the Land Forces definition more clearly explains how a collective might be expected to “work together effectively”, specifies the notions of “all arms environment” and considers the progressive elaboration of skills from individual upward through levels of higher complexity.

The NATO document on Aircrew Mission Training via Distributed Simulation states that “Collective training involves two or more ‘teams’, where each team fulfils different ‘roles’, training to interoperate in an environment defined by a common set of training objectives” (Research and Technology Organisation, 2004, p. 4). The RCAF simulation strategy notes that collective training in particular is in need of development, since lacking common mission definitions, each participant contributes their own perspective and the training remains at the individual level (Royal Canadian Air Force 2014a). The RCAF Simulation Strategy concludes that collective training has an incomplete framework and insufficient validation, in part perhaps because of a largely undeveloped collective training policy (Royal Canadian Air Force 2014b).

Even if the RCAF, CAF and NATO offerings were amalgamated, questions would remain with respect to the definition and application of collective training:

- How many members constitutes “collective”?
- Is there a difference between “collective” and “team”?
- How does collective behaviour differ at each of the unit levels?
- What types of skills produce “competent, cohesive and disciplined organizations”?
- To what extent are those skills “trainable”?
- How might one go about addressing those skills?

In other words any definition and use of collective training should address what sizes and structures of groups need to be trained, that the nature of training should address the specific level of collective activity, and that there are skills particular to group behaviour than can and should be trained.

Air Force Vectors enumerates six levels of collective training and their respective training activities. This ranges from Level 2, which is defined by the section, crew or detachment, and is focussed on battle drills and a high standard performance of battlefield tasks, through to Level 7, formation or brigade group level, which typically involves training through multinational or coalition operations. (see Annex B for the complete list).

While it is beyond the scope of this present exploration to address this definition directly, several assumptions with respect to CT were made to permit the analysis.

Here the analysis allowed that Collective Training refers to training that:

- is for a task, mission or objective that cannot be completed reasonably by one person alone;
- requires coordination, interaction, communication and collaboration among group members to complete the task, mission or objective;
- identifies, requires and cultivates positive interdependence of goals, resources, roles, and identity;
- produces competent, cohesive and disciplined organizations that are operationally deployable within realistic readiness timeframes;

- addresses specific performance and organizational objectives related directly to the organizational level being trained; and
- always includes at least one trainee interacting with other local or distributed group members (Other group members may also be trainees, or may be training support personnel playing the role of members of the group. These additional group members may also be virtual, constructive or synthetic entities).

1.4 Evaluated training analyses

Training needs analyses developed under the aegis of CFITES, and under the MEC approach were evaluated for their potential to meet the client-identified gaps. In each case the TNA was developed for the Joint Terminal Attack Controller (JTAC) role, which is typically used to provide close air support (CAS) for ground forces in a combat situation where integration and coordination of force elements is critical. Below are brief summaries of the CFITES and MEC processes and products.

1.4.1 Canadian Forces Individual Training and Education System

In brief, the Canadian Forces Individual Training and Education System (CFITES) is an elaboration of ADDIE approaches (Analysis, Design, Development, Implementation, and Evaluation) although it also includes an additional Validation phase. It provides a comprehensive set of doctrinal documents prescribing the conduct of a complete training management system. One component, the assessment process, examines overall gaps in performance, and determines which items can be addressed with training, and which can be addressed through better equipment, policy or procedure (National Defence, 1998a). Items that can best be addressed by training are then analyzed by a Qualification Standard Writing Board (QSWB). The QSWB is collection of SMEs in the role to be examined, and members of the training establishment, typically including a training development officer (TDO). TDOs provide information on best practices with respect to training and education, and have knowledge of CAF training policy. The board considers previous iterations of the standard (if any), recent developments in equipment and tactics, changes to policy or doctrine, as well as research, survey data or other information which may be relevant.

1.4.1.1 CFITES Qualification Standards

The QSWB produces a Qualification Standard (QS), a formal document that defines the tasks to be performed in the role, the conditions under which the task must be accomplished, the expected level of proficiency (1–5) and level of knowledge. These performance objectives are identified as “Train” or “No-Train”: some skills or knowledge needed for a given role may have been learned through on-the-job experience or previous training. Tasks from the “Train” list are selected and prioritized according to “high”, “moderate” or “low” priority. These are summarized as performance statements which represent groups of related tasks (National Defence, 2003).

1.4.1.2 CFITES Training Plan

The requirements in the QS are organized into a structured Training Plan, which describes what is to be learned, by whom and in what way. It further specifies how the learning will be assessed. Instructional strategies, assessment instruments, timings and appropriate media use are also included in the TP (National Defence, 1998b).

1.4.2 Mission Essential Competencies

The Mission Essential Competency (MEC) method is an extension of competency approaches, and endeavours to establish highly contextualized clusters of behaviour (both skills and knowledge) that are necessary for performance success in operationally relevant situations. The competency definitions are developed through a series of guided workshops with experienced SMEs, then validated in consultation with a larger sample of the operational community, and finalized in the Comprehensive Mission Needs Analysis and Determination (COMMAND) workshop. The methodology applies a grass-roots “operator knows best” philosophy to the problem of addressing training priorities.

1.4.2.1 MEC Summary report

The MEC Summary report provides a list of Mission Essential Competencies, their Supporting Competencies, Knowledge and Skills, as well a list of experiences deemed necessary and sufficient to develop the identified training requirements. Further, the report offers a determination of whether an item represents a gap, and the level of priority for training, as well as the required level of proficiency.

1.4.2.2 MEC COMMAND report

Survey summary data is analyzed and presented in the COMMAND worksheet. The included information allows users to view, filter and sort relationships among various questions including the importance of an experience for developing a MEC, which environments best promote its development, whether or not the area is a gap and priority for training as well as training frequency.

1.4.3 Knowledge, skills, attitudes, tasks and competencies

In both CFITES and MEC analyses, there are success criteria for candidates for any given role. For both systems these measures typically include readily available information necessary for success (*knowledge*), the capacity to perform sequences of actions to produce a desired effect (*skills*), and inherent candidate traits and characteristics (CFITES, *attitudes* or sometimes *aptitudes*; MEC, *supporting competencies*). The MEC definitions of knowledge and skills stipulates that they must be available under stress (Bennett, Alliger, Colegrove, Garrity, & Beard, 2013). In CFITES, KSAs are expressed through *tasks* which are defined as “*any substantive aspect of performance*” (National Defence, 1998c, p. 3). Tasks in the CAF contribute to both operational and Departmental requirements: in other words, whether deployed or in garrison, whether shooting a gun or shining your shoes. In contrast with a task, the Competency of the

MEC is defined as a contextualized, high-level function that “*a fully prepared pilot, crew, flight operator, or team requires for mission completion under adverse conditions and in a non-permissive environment*” (Alliger, Beard, Bennett, Colgrove, & Garrity, 2007, p. 14). In this way the MEC has potential to be better linked with strategic objectives than CFITES.

2 Comparison

2.1 Research approach

The research objective was to determine whether the RCAF's use of CFITES or perhaps another system might best address the training-related gaps identified by the simulation strategy report. To directly test this question by full implementation and comparison of several TNA methods would be prohibitively expensive, time consuming and logistically impossible. A minimal comparison would require an opportunity in the form of an occupation or role under the purview of the RCAF that has been the subject of more than one method of training needs analysis, and additionally would require a series of metrics to assess the efficacy of any TNA method with respect to the specific requirements of the simulation strategy. The opportunity and metrics are described below.

2.2 The opportunity

In 2015, Australia, Canada, New Zealand, United Kingdom and the United States jointly performed a MEC analysis of the JTAC role to develop a common training standard in response to the Memorandum of Agreement (MOA) (Joint Fire Support Executive Steering Committee, 2013), and NATO standardized agreement (STANAG) (North Atlantic Treaty Organization, 2014). Since Canada had already developed a training standard under the CFITES system, most recently updated in 2013, the two roughly parallel analyses provided an opportunity to compare the outputs of the two systems against criteria developed from the RCAF simulation strategy.

2.3 Assessment metric development

To provide structure to the evaluation of the two TNA methods' ability to address the client-identified gaps, the questionnaire was developed from the training-specific elements discussed in the RCAF simulation strategy. The rating instrument was designed to invite the input of raters with expertise in a range of subject matter, and to allow assessment of more than one TNA system. Importantly, the assessment metrics were not developed to address any specific gaps in the role (JTAC) under examination.

The RCAF Simulation Strategy 2025 report (Royal Canadian Air Force 2014a) specifies ten elements to address simulation-focused training as a strategic objective, specifically:

- force structure traced to strategic guidance;
- training requirements traced to force structure;
- device options traced to training requirements;
- device options rationalized into system requirements;
- consistent training scenarios;
- automatically-generated electronic training records;

- maximize lessons learned;
- standardized simulation-based instruction;
- standardized simulation-based evaluation; and
- continual improvement process.

Within that group, the report states a gap analysis identified four specific areas of deficiency with respect to simulation-based training, which will be the focus of the current exploration:

- No Defined Set of Missions in Support of Core Airpower Capabilities
- Lack of Consistent Training Requirements Analysis
- RCAF Collective Training Framework Incomplete
- Insufficient Validation of Collective Training

The description of each of the four gap areas provides key points about the nature of the gap, and suggests means for bridging the gap. In some instances, a solution was suggested that might possibly be addressed through an appropriately structured training architecture. In those instances, the problem description was used to generate criteria statements.

For example one item under “Lack of Consistent Training Requirement Analysis” states: “Translation of these training requirements to training system requirements is not as consistently followed. CFITES provides for method and media analyses that map training requirements to training methods and devices that can satisfy them. These mappings can then be used to define a system of training devices...”

This was reframed as the criterion: “The analysis provides a clear mapping between training requirements and appropriate instructional media use:”, with the choices “No mapping”; “Limited mapping”; “Some mapping”; “Strong mapping” and “Comprehensive mapping” as anchor items. Anchor items were tailored to each criterion.

In other instances, the problem description suggested a solution outside of the training architecture. For example the problem “...the opportunity to invest in more cost effective training solutions that can be provided to a larger number of user communities is often missed” can best be addressed through careful planning, procurement and deployment of training technology. In such instances, no criterion item was developed.

A questionnaire was developed, consisting of nineteen questions: twelve criteria statements, two evaluations concerning group level and five questions on usability (Annex D). The criteria statements were generated from the four deficiency areas. Each was followed by a five-point Likert scale to assess the level of compliance. In turn the scale was followed by an option to provide open-ended comment or examples. For the two evaluations of group level, the choices represented possible levels of unit organization to which the question might apply. In those cases, raters were invited to select as many answers as were appropriate, again with comment and example responses. Finally for the usability questions, five items each with a five-point Likert scale asked for the level of agreement from “strongly disagree” to “strongly agree”.

2.3.1 Raters

Email invitations were sent to five potential raters who have expertise in the JTAC role, training and education within the CAF, or a general expertise in education. The potential audience was restricted because the MEC materials may not be shared publically. All potential raters required working knowledge of TNA. No response was received from two, and one offered to perform the rating, but was unable to complete the questionnaire within timeframes required for publication. In the end, a convenience sample of three different raters assessed the two analysis documents. One is the author, who has examined the differences between the CFITES and MEC systems from a structural and philosophical standpoint and has an undergraduate degree in Education, a PhD in Neuroscience and extensive practical experience non-military teaching and curriculum development. One rater is a JTAC, senior JTAC trainer for the CAF, and has participated, both in Qualification Standards Writing Boards within the CFITES system, and in the COMMAND workshops for the Coalition MEC system, as well as the accreditation of foreign JTAC schoolhouses. The final rater was a Training Development Officer with the CAF with a master's degree in learning and technology specializing in training design and management, but naïve to the JTAC role. His current focus is on how the Royal Canadian Navy can better leverage modeling and simulation for training. Both CAF members were already knowledgeable of CFITES-type documents.

2.3.2 Procedure

Raters were sent an email with instructions, a web link to the questionnaire, and the following documents: Qualification Standard Forward Air Controller (CFITES) (National Defence, 2012); Training Plan Joint Terminal Attack Controller (CFITES) (National Defence, 2015b); Coalition Joint Terminal Attack Controller (JTAC) Mission Essential Competencies Final Summary Report (MEC) (The Group for Organizational Effectiveness, 2015b); and Comprehensive Mission Needs Analysis and Determination (COMMAND) worksheet (The Group for Organizational Effectiveness, 2015a).

The raters were instructed to examine the documents from one method, then immediately perform the online assessment of those documents. After reading and evaluating the outputs of one method, each rater read and evaluated the outputs of the second method. Raters were counterbalanced with respect to which materials they evaluated first. All reading and analyses were performed independently, and at each rater's convenience.

All questionnaires were presented on the raters' computers using FluidSurvey online questionnaire software (<http://fluidsurveys.com>). The data gathered fell within the definition of program review rather than human experimentation, therefore, no ethics research committee approval was required.

2.3.3 Rating procedure

Questionnaire results were downloaded from FluidSurvey and tabulated using Microsoft Excel. Responses on the Likert scale were assigned a value of 1–5, with 1 being the left-most response (poorest rating) and 5 being the right-most (best rating). Question 6 asked about the use of

simulation to present knowledge rather than skill-based content, in other words, use of simulation when other media might be more appropriate: in this case a higher number indicated a poorer rating. As a result, scale items for this measure were reversed before being tabulated.

Means of all ratings were calculated for each question as a value out of five. Additionally, questions were clustered into four categories reflecting each simulation training gap: links with strategic guidance; simulation and media use; collective training; tools for trainee assessment. There was an additional category for usability. Summary ratings for each category are the sum of all average ratings for each question, expressed as a fraction of the total number of points available for that category. For example a category with four questions would have 20 available points. Questions 7 and 9 allowed more than one response and were not averaged, nor were they included in the overall ratings for the five categories.

No statistical analyses were applied to any of the ratings: The number of ratings was too low to yield Fleiss' Kappa values (a statistical measure to gauge the reliability of agreement among raters). Further, we did not apply Cronbach's alpha to the ratings scales (a measure of the internal validity of the scales) because the questionnaire was intended to provide a structure for evaluation and discussion, rather than perform as a validated instrument. Arbitrarily, a difference of one full point was chosen as signifying an advantage for one system or the other.

3 Results

Results are presented for each category and question with a brief discussion of the raters' assessment, including anecdotal comments made by the raters for a given questionnaire item.

Table 1: The ratings obtained from each rater, as well as the means (\bar{x}). Note that for question 6, ratings are reversed, and for questions 7 and 9 all selections are listed, without means.

Question	CFITES	\bar{x}	MEC	\bar{x}
1. The learning objectives in the analysis document can be clearly linked with core capabilities defined by RCAF strategic guidance:	5, 2, 5	4.0	3, 5, 2	3.3
2. The role/group functions identified by the analysis document support the Airpower missions defined by RCAF strategic guidance:	5, 3, 3	3.7	3, 5, 3	3.7
3. The analysis demonstrates a logical link between training requirements and appropriate instructional media use:	3, 3, 2	2.7	2, 2, 3	2.3
4. The analysis calls for simulation-based training in the media mix:	3, 3, 2	2.7	3, 3, 3	3.0
5. Simulation-based training is suggested in all instances where skills or techniques are more important than information, or where live training would be costly, dangerous or impractical:	4, 1, 2	2.3	2, 4, 1	2.3
6. Simulation-based training is suggested where information is more important than skills or techniques, or where other training might be cheaper or more effective:	5, 4, 4	4.3	3, 3, 5	3.7
7. The analysis explicitly addresses training needs at these unit levels (check all that apply)? Levels 1–7:	1 1,2 1,5		1,7 1,2,3 1,4,5,6,7	
8. Regardless of your answer to question 7, the structure and outputs of this type of analysis could potentially be used to address training needs for this role (i.e., JTAC, pilot, etc.) at a level other than individual:	3, 2, 4	3.0	4, 4, 2	3.3
9. What other levels could be addressed (check all that apply)? Levels 2–7:	2,3,4,5 2,3,4 2,3,4,5,6,7		2,3,4,5,6,7 2,3,4 2,3,4,5,6,7	
10. The analysis clearly identifies TTPs required for a given unit level (Tactical Air Control Party, crew, detachment, battle group, etc.) to operate functionally at that level:	4, 2, 1	2.3	3, 1, 2	2.0
11. The training suggested by this analysis is likely to contribute to operational readiness:	4, 3, 3	3.3	5,5,4	4.7
12. The analysis provides a clear link between suggested training activities (FTX, force-on-force, etc.) and the unit level:	1, 3, 2	2.0	1, 2, 2	2.2
13. The analysis provides tools and instruments to gather data about trainee performance:	4, 3, 5	4.0	3, 1, 4	1.7
14. The analysis, its tools and instruments are sufficient to provide guidance on amending and improving the training program:	4, 3, 3	3.3	3, 1, 4	2.7
Based on my exploration, overall I would say the output document...				
15. was clear and understandable	4, 4, 4	4.0	4, 4, 4	4.0
16. was easy to navigate	4, 3, 4	3.6	4, 4, 4	4.0
17. needed no further explanation or support	4, 2, 4	3.3	2, 3, 3	2.7
18. contained meaningful information	4, 3, 4	3.6	4, 4, 4	4.0
19. contained the right amount of information	4, 3, 4	3.6	2, 3, 4	3.0

3.1 Links between Strategic Guidance and Training

Overall Rating: Links between Strategic Guidance and Training

CFITES: 11/15, **MEC:** 11.7/15

Question 1: The learning objectives in the analysis document can be clearly linked with core capabilities defined by RCAF strategic guidance:

CFITES: 4, **MEC:** 3.3

Overall, all raters felt that *some* to *many* learning objectives from both the CFITES and MEC documents could be linked with core capabilities. For the MEC this linking requires some extrapolation as a result of differences of vocabulary between the two documents. The linking is from the high level MEC to the Airpower Capabilities. For both systems, not all Airpower Capabilities are supported in these analyses of the JTAC role, and further the JTAC role supports capabilities which may be required by other elements. Core Capability of Support to Joint Operations and the Civil Power does not include the awareness of the ground situation from a forward position, which is provided by the role.

Question 2: The role/group functions identified by the analysis document support the Airpower missions defined by RCAF strategic guidance:

CFITES: 3.7, **MEC:** 3.7

The raters felt that the functions *somewhat* support the Airpower missions defined by RCAF strategic guidance. Regardless of the analysis method, however, the Airpower missions focus on elements that will directly benefit air power, and consequently some joint operational aspects of the JTAC would support missions beyond the airpower list. In the MEC analysis, Communication, Interpersonal Skills, Teamwork and Credibility are mentioned as supporting competencies, and would certainly support aspects of the airpower missions. The Airpower mission focus on SIGINT and IMINT bypasses the strength of JTAC intelligence, surveillance and reconnaissance of the forward ground position. Because many of the functions of CAS/JTAC are linked to ground activity, not all airpower missions are completely supported. This is the nature of the role, rather than the nature of the analysis.

Question 11: The training suggested by this analysis is likely to contribute to operational readiness:

CFITES: 3.3, **MEC:** 4.7

The CFITES training was rated to contribute *some* to *much* readiness, while the MEC training was rated to contribute *much* to *extensive* readiness. In the CFITES system, because much of the teaching is lecture based, it may not necessarily result in operational readiness: In the words of the strategy document, trainee formation needs to “train the brain” and “hone the hands” (Royal Canadian Air Force 2014a, p. 16). In some instances, training is prescribed with a given piece of equipment, however it is not clear to what extent the training takes place in an operationally meaningful context. In many instances, the learning is to be confirmed in field training exercises,

which would itself contribute to readiness. In the MEC system the training focuses on skills and knowledge applied in highly contextualized, operationally relevant situations. This may be the particular advantage of a competency-based approach.

3.2 Media, training requirements and simulation

Overall Rating: Media, training requirements and simulation

CFITES: 12/20, **MEC:** 11.3/20

Question 3: The analysis demonstrates a logical link between training requirements and appropriate instructional media use:

CFITES: 2.7, **MEC:** 2.3

For both CFITES and MEC, raters assessed only limited logic between training requirements and appropriate media use. For CFITES, one rater noted that the lecture method was determined to be the correct media in nearly every instance with the rationale in the training plan that “Lecture method of instruction was selected to introduce new material”. Tests were to be oral or quiz format and assessment of learning was to be “performed during field training exercises”. For Control exercises, four of twelve need to be live/training/inert ordnance; of those, two must be at night. Overall, the training of tasks and testing of learning is not contextualized within a broader CAS activity as might be found in a simulation. The Coalition JTAC COMMAND document provides suggestions about what developmental experiences could be trained in what learning environment, but does not specifically recommend media. In the instance of MEC, media are not recommended per se, but rather judged by raters as suitable to deliver a given developmental experience.

Question 4: The analysis calls for simulation-based training in the media mix:

CFITES: 2.6, **MEC:** 3

CFITES was rated as calling for *limited* simulation-based training, and MEC was rated as calling for *some* simulation-based training. In the CFITES training plan, simulation use was stipulated in only four instances. The nature of the MEC analysis allowed users to rate the type of training environment for its perceived effectiveness for a given developmental experience, but the MEC does not mandate the use of the preferred or any media: it is at the discretion of the trainer. The MEC survey asked “Please rate to what extent it is reasonably possible to provide each experience in each environment under current conditions.” However, the rating might not accurately reflect whether or not simulation *should* be used. As an example, MEC survey respondents were asked to rank the effectiveness of each environment for training “Conduct CSAR [Combat Search and Rescue] (multiple aircraft, saturated airspace)”. The school was rated as 1.2 (slight), accredited simulators were rated only 1.5 (slight), and combined arms/joint and coalition exercises were gaged as 2.3 (moderate) and combat ops were gaged as 3.0 (to a substantial extent). The accredited simulator was ranked only slightly above the classroom, which is surprising since a classroom would provide only theoretical information despite the fact that in a simulator, trainees would have opportunities to practice actual scenarios. Raters also questioned

the definition of “simulation-based training”, noting that the definition would influence the rating. Does one include table top exercises and dry-runs?

Question 5: Simulation-based training is suggested in all instances where *skills* or *techniques* are more important than information, or where live training would be costly, dangerous or impractical:

CFITES: 2.3, **MEC:** 2.3

For the teaching of skills or training in scenarios that would be dangerous or impractical to conduct live, raters observed that simulation-based training was suggested in *few instances* by either method. For the CFITES analysis, raters observed very limited prescription of simulation use, with lecture being recommended in almost every instance regardless of the nature of the training to be conducted. In the MEC analysis, in no instance is simulation recommended preferentially compared to live exercises or combat operations. This may be due to the nature of the question to the SMEs which asks if a developmental experience can be provided: simulation is a possibility, but it is not preferred. Again this may be a matter of limitations as seen by the SMEs who conducted the CFITES and MEC analyses, which may or may not reflect actual limitations in simulation-based training.

Question 6: Simulation-based training is suggested where *information* is more important than skills or techniques, or where other training might be cheaper or more effective:

CFITES: 4.3, **MEC:** 3.7

This scale was reversed from the questionnaire: high values meant mean the rater determined that simulation was misapplied in few instances. For CFITES, the raters determined that simulation was misapplied in nearly *no instances*, while for MEC simulation was recommended in *some* inappropriate instances. While this could indicate that the raters felt that simulation was not used inappropriately, it may also simply reflect the extremely rare recommendation of simulation as a training media. Equally, one rater commented this item was difficult to judge without domain specific knowledge of cost analyses.

3.3 Collective training

Overall Rating: Collective Training

CFITES: 7.3/15, **MEC:** 7.7/15

Question 7: The analysis explicitly addresses training needs at these unit levels (check all that apply)?

This scale was a series of check boxes expressing the various levels of collective training as documented in *Training for Land Forces* (2001) (see Annex B). Raters were asked to select all levels they felt were addressed in the current analyses.

All raters felt that both CFITES and MEC analyses addressed individual training. One rater evaluated CFITES to address one higher level of collective training. One rater evaluated that at

least two CFITES enabling objectives supported combined arms, citing EO 402.05 – 01.16 Plan integrated attack by multiple fire support assets to support CAS, and T0080 03.5 executing deconfliction of aviation assets. Two raters felt that the MEC also addressed higher levels of collective training; however there was no consensus among the raters regarding which levels were addressed.

One rater cited the following examples of developmental experiences that would explicitly address collective training needs:

- 3. Participate in a live fire CAS exercise at reduced safe distances: Combined arms or sub-unit.
- 28. Conduct a CAS training event with Coalition aircraft.
- 29. Operate with Coalition forces.
- 45. Operate in a different echelon.

Question 8: Regardless of your answer to question 7, the structure and outputs of this *type* of analysis could potentially be used to address training needs for this role (i.e., JTAC, pilot) at a level other than individual:

CFITES: 3, **MEC:** 3.3

The raters determined that although few levels of collective training were explicitly addressed in the present document that both types of analysis had *some potential* to respond to collective training needs. In terms of the CFITES analysis, to apply the analysis to levels other than individual may be a matter of structuring the skills and knowledge, performance objectives and enabling objectives to include interaction with other collective levels. However, it would also be necessary to restructure the scope or description of the role. The MEC analysis could demand developmental experiences for any number of levels: this is limited by the structure of the developmental experience, and the identified skills and knowledge for a given role.

Question 9: What other levels could be addressed (check all that apply)?

After predicting the potential for applying the analysis beyond its current levels of application, raters then judged the levels to which the analysis might be successfully applied. All raters agreed that level 2 (section, crew or detachment), level 3 (troop or platoon) and level 4 (squadron or company) could be sufficiently addressed by either type of analysis. One rater felt all additional levels could be addressed by both methods. Another rater felt only the MEC analysis would be able to address all remaining levels, and the third rater felt that additionally only level 5 (combined arms, sub-unit) could be addressed by CFITES.

Question 10: The analysis clearly identifies TTPs required for a given unit level (Tactical Air Control Party, crew, detachment, battle group, etc.) to operate functionally at that level:

CFITES: 2.3, **MEC:** 2

Both analyses were rated to provide only *few* level-specific TTPs. Neither analysis provides clear linking between specific TTPs and a given level of collective training. In CFITES all TTPs seem

to be related to the individual, however TTPs are developed for working within a given sub-unit or organization, and JTAC specific TTPs are taught as part of training but are further developed when working in direct support of the JTACs home unit. For the MEC analysis each developmental experience is directly mapped to specific skills and knowledge. They are not linked explicitly to specific levels, but some appear to address levels other than individual.

Question 12: The analysis provides a clear link between suggested training activities (FTX, force-on-force etc.) and the unit level:

CFITES: 2, MEC: 2.3

Raters judged training activities in both analyses to be *weakly* linked to the unit level to be trained; however, it is worth remembering that most training is focused on the individual. For CFITES one key exception is deconfliction, where the training activity can only occur with a level other than individual. For the MEC analysis, the unit level would need to be extrapolated from each developmental activity.

3.4 Tools and instruments

Overall Rating: Tools and Instruments

CFITES: 7.3/10, MEC: 4.3/10

Question 13: The analysis provides tools and instruments to gather data about trainee performance:

CFITES: 4, MEC: 1.6

In this instance the raters judged that CFITES provided *many* tools to assess trainee performance, while the MEC analysis provided *few* tools. In CFITES, the Qualification Standard document provides tasks and required proficiency levels, as well as clear and detailed indicators of achievement for each proficiency level. Further, the analysis describes whether the task is to be trained or not. Finally, the Training Plan offers a comprehensive set of check box and evaluative forms allows for assessment of trainee progress and performance on a variety of specific tasks and types of equipment. In the MEC analysis each KS item is identified by a level of Not Applicable (NA), Basic (B), Intermediate (I), or Advanced (A). The levels are simply defined, and assigned a priority level: High, Intermediate, Low, and No. Information regarding the importance of each item can be ranked and the required level could easily be extrapolated to determine trainee performance, however no purpose-made instruments are offered as part of the output documents.

Question 14: The analysis, its tools and instruments are sufficient to provide guidance on amending and improving the training program:

CFITES: 3.3, MEC: 2.6

In both instances, the analyses were rated as providing *somewhat sufficient* guidance for amendments and improvements to the training program. The CFITES analysis does not provide a

clear link with RCAF mission statements, hampering the ability to determine to what extent the training meets overall organizational objectives. However, there is an identification of gaps that can be overcome by training, and tools for assessing trainee progress, which could in turn be applied to evaluating the training program. Overall, the MEC methodology reveals training gap items, their required level of performance and priority. These are critically important providing a list of “what to change, when, and by how much”. These items are placed in a meaningful operational context, and given a subjective judgement of appropriate training media. This is excellent, but does not provide meaningful measures against which trainee progress can be determined: as a result it would be more difficult to assess and improve the training program. Additional analysis tools and instruments would be required to determine if the analysis had in fact produced a change.

3.5 Usability and clarity

Overall Rating: Usability and Clarity

CFITES: 18.3/25, **MEC:** 17.7/25

Question 15: The output document was clear and understandable:

CFITES: 4, **MEC:** 4

Question 16: The output document was easy to navigate:

CFITES: 3.7, **MEC:** 4

Question 17: The output document needed no further explanation or support:

CFITES: 3.3, **MEC:** 2.7

Question 18: The output document contained meaningful information:

CFITES: 3.7, **MEC:** 4

Question 19: The output document contained the right amount of information:

CFITES: 3.7, **MEC:** 3

The measures in the case of these five usability questions determined the extent to which the raters agreed with the statements, with a score of 1 representing strong disagreement, 5 representing strong agreement, and 3 representing a neutral stance toward the statement. The raters *agreed* with the statements that the output documents of both systems were clear and understandable, easy to navigate, and contained meaningful information. The raters felt *neutral* to the statement that the output document required no further explanation. Though not different by the arbitrary criterion of one full point, the raters *agreed* that the CFITES document contained the right amount of information, but were *neutral* to the statement that the MEC output contained the right amount of information, however no rater provided additional anecdotal feedback to clarify whether either system contained too little or too much information.

4 Discussion

With respect to the criteria developed from the RCAF simulation strategy, neither CFITES nor the MEC approach were rated to be adequate to fully address all gaps and issues identified by RCAF Simulation Strategy 2025, nor did either system appear to be a clear ‘winner’ overall. The CFITES system was rated higher for its trainee evaluation tools, and the MEC system was given a stronger rating with respect to providing opportunities for operational readiness.

4.1 Strategic guidance is not explicit at outset

In terms of demonstrating links with strategic guidance, both products were judged to show a relationship with a small subset of core capabilities and airpower missions (Annex C). In part this weakness may have been because the JTAC role is not exclusively committed to support the RCAF, but also to joint or coalition forces: necessarily, the role will support other environments, so some capabilities and missions addressed by the role are beyond those expressed in the Air Force Vectors strategic document (Royal Canadian Air Force, 2014). A different specific role, such as pilot or navigator might possibly be developed in a manner that more directly supports specific airpower missions; although such development might not be desirable for the JTAC role specifically.

It is unknown whether explicit reference to strategic guidance documents was made in either the CFITES or MEC analyses. Still it is conceivable that if guidance documents were referenced from the outset of the development of either analysis, that clearer, more deliberate and explicit links could be developed between the guiding organizational principles and the suggested training. It is worth considering that because the MEC analysis relies on grass-roots development of the competencies, supporting competencies and developmental experiences, that doctrinal and strategic considerations may be implicit rather than explicit. In other words the consultation with the broader operational community will invoke the culture and doctrine of strategic guidance as understood and interpreted by those being directed, as opposed to by those providing direction.

The RCAF Simulation strategy observes that there is “no defined set of missions in support of core airpower capabilities” (Royal Canadian Air Force 2014a, p. 42). In the CFITES training plan, “control” exercises provide training in somewhat contextually relevant situations, but these do not explicitly link with air power missions. Still, while controls do require collections of job-relevant tasks to be performed in a logical and coherent manner, one may question the degree to which these exercises impose the stress and exigency of mission completion under combat conditions. By contrast, the MEC approach does address various mission parameters through its application to highly contextualized “developmental experiences”. This is responsive to higher level doctrinal guidance to fulfill expectations of the American Air Force Universal Task List (Best, Galanis, Kerry, & Sottolare, 2013). In the case of the JTAC MEC analysis, the SMEs were not to the author’s knowledge specifically responding to any guidance document, and it would be necessary to link the work with Canadian strategic guidance documents.

4.2 Media use and simulation are not strategically guided

Both analyses fared quite poorly with respect to overall media use and neither explicitly promoted the use of simulation as part of the training. Possible reasons for the failure are distinct between the two methods, since the training media are stipulated top-down by CFITES SMEs and TDOs, while in the MEC method the operators provided their perspective. In the case of the MEC survey, the question asked the extent to which respondents felt a training experience could be provided in various conditions, including using accredited and non-accredited trainers. This is not equivalent to an objective assessment by an expert in training methodologies. Respondents never ranked simulation higher than other modes of training. Regardless the rating is a measure of the method's acceptability rather than its superiority. Certainly, those developing training plans based on the MEC analysis could impose simulation-based training on the developmental experiences recommended by the report; however such intervention denies the fundamental benefit of soliciting engagement from the operational community.

Regardless, one must not make assumptions about the grasp of simulation-based training by those performing either the CFITES or MEC analyses. SMEs may over-estimate the value of live training, or underestimate the potential of simulation-based training. Equally, they may be unaware of the state-of-the-art for simulation-based training, and be prejudiced against it. On the other hand, SMEs may be painfully aware of technical issues with simulation-based training, or access and opportunities with simulation-based trainers, or alternatively, it may simply be an issue that simulation is perceived as being less valid than live training (DeCarlo, Collingridge, Grant, & Ventre, 2008). Additional exploration of the acceptance of simulation-based training may be useful to identify and overcome attitudinal and practical barriers.

4.3 The collective aspects of the role are not reflected in its description

Neither analysis method strongly addressed collective training demands. It is possible that the definition of the role provided to the SMEs performing the analysis may have precipitated this deficiency. For example, if the role had been defined as requiring specific types of interdependence at various levels of collective behaviour, say with both platoon and battalion groupings, then it is more likely that specific Performance and Enabling Objectives or Mission Essential Competencies or Supporting Competencies would have been developed to address them. What may be needed to facilitate development of collective training requirements is an understanding and description of the role underscoring its collective nature. While the individual knowledge, skills and aptitudes may contribute to what the Training for Land Operations calls "qualified soldiers", the definition of *each* role might need to include KSAs that would anticipate the production of "competent, cohesive and disciplined organizations that are operationally deployable within realistic timeframes". That is, any training of the individual can and should include development of KSAs that will be useable in a collective environment. By more clearly defining roles in a context that includes interdependence and collective behaviours POs and EOs, MECs and SCs could more deliberately be developed to nurture the appropriate KSAs.

4.4 Limitations

This analysis was based on survey questions that specifically referenced *gaps* identified in the RCAF Simulation Strategy report. These gap items are a subset of the ten elements considered critical for the overall implementation of the report objectives. That is, the present report focuses on how each TNA bridged gap items, but does not consider how well the respective TNAs might address the other critical elements. Additionally, the gaps identified by the client were taken to be valid and comprehensive, and were not scrutinized in this report. Further the analysis does not include cost/benefit considerations, time use or any scientific comparison of training effectiveness emerging from the two systems. Additionally, no attempt was made to compare the gap items or training requirements identified by each TNA for the JTAC role. At 242 discrete items for the CFITES analysis, and 208 items for the MEC, it was well beyond the scope and intent of this paper to compare these outputs.

It is possible that the Likert scale items developed to assess the CFITES and MEC products did not have sufficient granularity to show differences between the two systems. Increasing the number of steps in the scale, or providing a sliding scale may have illuminated differences between the two systems. Equally, it is possible that more raters or possibly more inter-related or duplicate rating items may have led to a more highly refined rating.

Beyond possible shortcomings in the scale or the criteria chosen for this analysis, issues with the wording of the questions themselves and comprehensive knowledge of the source documents may have impeded better assessment by the raters. In two instances one rater commented that additional information about media use and training objectives would be required to answer a question with full understanding, although the other raters each addressed the question without reservation. Equally question clarity and specificity could be improved. Question 6 in particular requires an assumption that simulation might possibly be overused, leading to application in instances where another form of training might be superior however neither the CFITES nor MEC TNA documents suggest that to be the case.

Also, the term “simulation-based training” was not clearly defined in the questionnaire, and the raters, while appearing to understand the overall concept raised some concerns about how far the term should be stretched. The question could be improved by including the definition from the RCAF strategy, namely a “system which skilfully leverages live, virtual, and constructive (LVC) domains within a networked common synthetic environment” (Royal Canadian Air Force 2014a, p. xiii).

In another instance of limitations imposed by wording, questions 5 and 6 use the phrase “Simulation-based training is *suggested*...”, which may have presented some difficulty for the raters, and lead to some problems in analysis. The CFITES Training Plan decisively *stipulates* media use for each Enabling Objective, and the MEC COMMAND summary shows the *preference* of the operational community for a given media for a particular Developmental Experience. In neither instance is the use of simulation *suggested*. The use of the word “promoted” or “prioritized” over “suggested” could overcome this difficulty, and more directly address the gap area.

In addition to the rating questionnaire, the number and backgrounds of the raters may have imposed limits on the analysis. One of the raters may not have been neutral toward the use of simulation, as suggested in the two comments below. The second comment in particular seems to

indicate that rater does not see the use of the simulator as a form of training. This does not invalidate the rater's assessment, but does frame it within the current discussion:

“Simulation is a tool, when used correctly can enhance procedures and improve situational awareness. At this point it cannot replicate a live training event or working through problems associated with atmospheric or environmental conditions.”

“Simulation conducted within the QS/TP for FAC (JTAC) is used to enhance training not to replace training.”

Still, the nature of the questions does not require the rater to be neutral with respect to their assessment of the benefit of simulation, and further, differing opinions (whether neutral, negative or positive) may provide a more balanced picture of the area under analysis despite the additional noise in the data.

This particular analysis tool was purpose-built to address client-identified gaps in the RCAF Simulation Strategy. Some of the limitations in the current research could be addressed with refinements to the tool. Alternatively, one could make comparisons using a broader model such as the one used for collective training needs analysis for a new class of aircraft carriers in the British Navy (Sennett et al., 2015), although such an exploration would lack the specificity of the current report.

5 Conclusion

This report examined the extent to which the products of two training analysis systems addressed unmet requirements identified in the simulation-based training strategy called for in the RCAF Simulation Strategy 2025. Questions were developed to assess the degree of conformity between the analysis products and the identified gaps, on a five point scale. Three raters with expertise in differing aspects of training and education, modeling and simulation and training within the JTAC role assessed the QS and TP documents of the CFITES system, and the Summary and COMMAND reports of the MEC system.

Overall, neither system was rated as offering a distinct advantage nor better promoted a simulation-first training strategy. The present version of the CFITES-derived JTAC training plan relies primarily on lecture and confirmatory exercises using field training with live assets as the required training media. The MEC analysis, on the other hand reflects the JTAC community's belief that training media other than simulation is most effective, and could dissuade trainers from using simulation in the media mix. However, each system did offer advantages to address one of the simulation strategy gap items. CFITES was better rated as providing tools to measure trainee learning. This was likely due in part to the clear elaborations of the definitions of levels for various performance criteria, but also perhaps because of the many checklists and evaluation tools available in the Training Plan. The MEC method was judged to provide better opportunities for operational readiness because of the highly contextualized developmental experiences. This advantage for the MEC model may be due to CFITES primary use of lecture as a training medium, which may have been perceived as less robust than other methods.

The two analysis systems were each rated to have some links between the JTAC role, its performance measures, and strategic objectives of the RCAF as expressed in Core Capabilities and Airpower missions, although not all capabilities or missions were addressed, and many JTAC performance measures from the CFITES and MEC analyses did not have a direct correlation with any capability or mission. With respect to providing a well-developed rationale for appropriately matching training media with training experiences and providing guidance on leveraging simulation as a means to deliver optimal training, neither CFITES nor MEC was very effective in this case. Likewise, the JTAC role requires integration of many levels of collective behaviour, yet collective training objectives were not explicitly addressed by either system.

In order to promote a simulation-first strategy either system could be supplemented by clearly defined stipulations for the inclusion of simulation-based training or explicit decisions regarding its sufficiency, as well as by thorough media analyses. However, an explicit prescription of simulation-first strategy might more effectively be applied in a top-down system like CFITES in contrast to the bottom-up, highly consultative MEC process. In a similar way, to ensure development of KSAs specific to collective behaviour, requiring interactions with the collective should be explicitly addressed in the task analysis and subsequently addressed in the training analysis, which could better be done in a prescriptive manner. JTAC SMEs are most likely to define the role in the way they were trained, and in the manner that corresponds to their current behaviour. The weak treatment of collective behaviours by the two systems may simply be a result of starting with a definition of the JTAC role that does not explicitly recognize the highly variable nature of the missions, nor the highly interdependent nature of the role.

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Annex A Simulation-Based Training Deficiencies

From Royal Canadian Air Force Simulation Strategy 2015

7.1 Simulation-Focused Training Deficiencies

The following observations are assessed as contributed significantly to the non-compliance issues facing the RCAF in the *Simulation-focused Training* strategic objective. Addressing these issues should be a major focus of the RCAF M&S Strategic Roadmap.

7.1.1 No Defined Set of Missions in Support of Core Airpower Capabilities

Air Force Vectors defines five core airpower capabilities:

- Control of the Air;
- Attack;
- Surveillance and Reconnaissance;
- Air Mobility; and
- Support to Joint Operations and the Civil Power.

Under each of these capabilities are Core Roles and Airpower Missions. These roles and missions are discussed in *Air Force Vectors* at a high level, but lack sufficient detail to trace specific elements of the force structure to specific detailed missions. A more precise understanding of these missions will vastly improve the RCAF's ability in the areas of force development, force readiness, and training, as decisions in these domains are enhanced by a clear understanding of what functions need to be performed. Conversely, the training required to both build and ensure the readiness of a capability is compromised when the required missions are not commonly understood or shared. This situation undermines attempts to advance any RCAF training, much less facilitate its transfer from live to virtual-based means.

7.1.2 Lack of Consistent Training Requirements Analysis

The DND/CAF has a well-defined training analysis process in CFITES. It is well implemented for the development of individual qualification standards and training programs, but suffers from a lack of common mission definitions to produce a consistent understanding of the on-the-job performance required across all fleets. Translation of these training requirements to training system requirements is not as consistently followed. CFITES provides for method and media analyses that map training requirements to training methods and devices that can satisfy them. These mappings can then be used to define a system of training devices that represents an optimal balance of training fidelity (cost) and capability. This latter process is rarely followed, resulting in limited training requirements to support training device acquisition. As a result, the tendency is to default to commercial standards (ICAO) for flight simulators that may not meet unique military mission requirements. Additionally, the opportunity to invest in more cost effective training solutions that can be provided to a larger number of user communities is often missed.

7.1.3 RCAF Collective Training Framework Incomplete

The RCAF collective training framework draws upon the Army Systems Approach to Training (ASAT) but fails to address adequately training of the Air Detachment (Air Det) core components of the Air Task Force. The ASAT achieves operational readiness for the Army through an incremental approach to training where each level of training is conducted and verified and the trained units are then merged to form the unit under training at the next level. This approach works well for the army given their force structure. RCAF force structure differs from the Army in that the size and capability of formed units can differ significantly, particularly at Levels 3 and 4. The mapping of Level 3 to Flight and Level 4 to Squadron generally does not reflect how Air Det components train or how they are assigned to the ATF. For example, 405 Sqn would not deploy as a unit to provide CP-140s to the ATF. As a result, the RCAF collective training framework attempts to achieve overall flexibility by integrating operationally ready Air Dets, of any combination necessary to the assigned mission, while leaving the details of the training required to achieve this level of readiness to the individual communities. A lack of clearly defined collective training requirements for the Air Dets leads to the situation observed in Annex A – the RCAF participates in a great number of live exercises, but the exact purpose of these exercises, how they support operational readiness of the Air Dets, or even which specific RCAF assets should participate in each exercise and why is not readily discerned.

7.1.4 Insufficient Validation of Collective Training

This gap is related to 8.1.3 [sic], as the lack of comprehensive collective training needs hampers the ability to validate the training that is conducted. Without validation, it is impossible to make an accurate assessment of the effectiveness of the collective training program. The RCAF also lacks a single organization with the authority and mandate to validate the collective training program.

Annex B Levels of collective training

From Training for Land Operations

Level		Remarks
Level 7	Fmn (bde group)	<ol style="list-style-type: none"> 1. Training at this level may be multinational and may include a requirement to understand higher-level coalition operations. 2. Increased emphasis will be placed on FSO within a JIMP context.
Level 6	Unit and combined arms unit (battle group (BG) / battalion group (bngp))	<ol style="list-style-type: none"> 1. This includes unit training in non-manoevre units prior to incorporation into another unit or fmn. 2. Level 6 CAXs and CPXs should be used for command and staff training, in both FSO and domestic operations (dom ops) scenarios. 3. Level 6 field training will generally be limited to training for high readiness and will be confirmed by force-on-force training. 4. All Level 6 training will generally take place in a joint and combined context.
Level 5	Combined arms sub-unit	<ol style="list-style-type: none"> 1. Level 5 training is the CA's vital ground in terms of CT. During training for high readiness, Level 5 training shall include live fire training. 2. Level 5 training is conducted by combat teams (cbtms), company groups (coy gps) or other multi-disciplinary sub-unit organizations (ie, an All-Source Intelligence Centre (ASIC), a forward support group (FSG) or a field artillery battery). 3. Enhanced Level 3 may be used to describe combined arms operations at the sub-sub-unit level, in a Level 5 context. 4. It is at this level that the synchronization of arms and services becomes critical.
Level 4	Sub-unit (squadron (sqn) / coy)	<ol style="list-style-type: none"> 1. Similar to Level 3, focused on TTP training. 2. Training a sub-unit to this level will generally be required by a FG unit prior to forming a combined arms unit or JTF.
Level 3	Sub-sub-unit (troop (tp) / platoon (pl))	<ol style="list-style-type: none"> 1. Increased command and control challenges. 2. Tactical situations should be less predictable than Level 2, and battle drills should be less detailed.
Level 2	Section (sect) / crew/det	<ol style="list-style-type: none"> 1. Generally battle drills, aimed at executing battlefield tasks to a high standard. 2. Combat battle tasks training should generally culminate in a Level 2 live fire event (stand or FTX).

The above are *levels* of collective training.

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Annex C Core Airpower Capabilities, roles and missions

CAF Core Airpower Capabilities	Core Roles	Airpower Mission
Control of the Air	Battlespace Management	Airspace Control, Navigation Systems, Enable Air Commerce, Air C2
	Counter-air	OCA, DCA, Air Defence
Attack	Counter-land	Interdiction, CAS
	Counter-sea	ASW, ASUW
	Strategic Effect	Deep Strike
Surveillance & Reconnaissance	Persistent Surveillance, Routine Patrols, Cued Reconnaissance	RAP, Early Warning
Air Mobility	Airlift	Strategic or Tactical
	AAR	
Support to Joint Operations and the Civil Power	Maritime Support	ASW, ASUW
	Air mobility	Battlefield Mobility, Special Ops
	Personnel Recovery	SAR
		Aeromedical Evacuation
Situational Awareness	SIGINT, IMINT	

Adapted from Air Force Vectors, 2014.

The core capabilities and roles present “what” CAF airpower <i>must</i> do and are prescriptive for the RCAF. The B-GA-400 doctrine series describes “how” airpower is employed to accomplish these core requirements.	
Core Capability	Each core capability provides a discrete set of effects that leverage airpower’s strengths and advantages and can be conducted independently or is provided primarily by the Air Force in support of critical joint requirements. While some of the missions and tasks can also be conducted by other environments, for example, naval fires ashore or indirect land fire in a counter-air effort, they will be limited to situations where sustained operations, range, and mass are inconsequential. These core capabilities and roles will typically be planned, tasked, and executed with the air component commander (ACC) as supported commander.
Core Role	Each core capability has one or more subordinate core roles and associated missions that are required to achieve full effect. Force development and force generation (FG) responsibility for these roles remains primarily with Comd RCAF.

Airpower Missions	These are the missions the RCAF will conduct to achieve the core capabilities and roles needed by CAF airpower. Air doctrine, including tactics and procedures to conduct these missions is developed by the RCAF and feeds, in turn, CAF joint doctrine.
Core Capability	In the Canadian context, the RCAF is the sole provider of airpower considered organic to—and therefore a critical requirement of—other environments. This core capability and the subordinate roles and missions will be executed by RCAF assets and personnel, typically under operational command (OPCOM) or operational control (OPCON) of another commander.
Core Role	These roles and subordinate missions may be conducted by the RCAF alone; however, the effects are part of a larger joint effort. Search and rescue (SAR) is mandated by the GC and conducted primarily by RCAF assets (as either a primary or secondary role); civilian (Civil Air Search and Rescue association [CASARA])

Annex D Questionnaire Questions

1. The learning objectives in the analysis document can be clearly linked with core capabilities defined by RCAF strategic guidance:

No L.O.s
can be linked Few L.O.s
can be linked Some L.O.s
can be linked Many L.O.s
can be linked Most L.O.s
can be linked

Examples and Comments:

2. The role/group functions identified by the analysis document support the Airpower missions defined by RCAF strategic guidance:

Functions
do not
support
missions Functions
weakly
support
missions Functions
somewhat
support
missions Functions
mostly
support
missions Functions
completely
support
missions

Examples and Comments:

3. The analysis demonstrates a logical link between training requirements and appropriate instructional media use:

No
logic Limited
logic Some
logic Strong
logic Comprehensive
logic

Examples and Comments:

4. The analysis calls for simulation-based training in the media mix:

No
simulation-
based training Limited
simulation-
based training Some
simulation-
based training Mostly
simulation-
based training Exclusively
simulation-
based training

Examples and Comments:

5. Simulation-based training is suggested in all instances where *skills* or *techniques* are more important than information, or where live training would be costly, dangerous or impractical:

- In no instances
 In few instances
 In some instances
 In most instances
 In all instances

Examples and Comments:

6. Simulation-based training is suggested where *information* is more important than skills or techniques, or where other training might be cheaper or more effective:

- In no instances
 In few instances
 In some instances
 In most instances
 In all instances

Examples and Comments:

7. The analysis explicitly addresses training needs at these unit levels (check all that apply)?

- Level 1 individual
 Level 2 sect, crew, det.
 Level 3 troop, platoon
 Level 4 squadron, company
 Level 5 combined arms sub-unit
 Level 6 battle group, battalion group
 Level 7 formation, brigade

8. Regardless of your answer to question 7, the structure and outputs of this *type* of analysis could potentially be used to address training needs for this role (i.e. JTAC, pilot, etc.) at a level other than individual:

- No potential
 Limited potential
 Some potential
 Much potential
 Unlimited potential

Examples and Comments:

9. What other levels could be addressed (check all that apply)?

- Level 2 sect, crew, det
 Level 3 troop, platoon
 Level 4 squadron, company
 Level 5 combined arms sub-unit
 Level 6 battle group, battalion group
 Level 7 formation, brigade

10. The analysis clearly identifies TTPs required for a given unit level (Tactical Air Control Party, crew, detachment, battle group, etc.) to operate functionally at that level:

- No level-specific TTPs
 Few level-specific TTPs
 Some level-specific TTPs
 Many level-specific TTPs
 Comprehensive level-specific TTPs

Examples and Comments:

11. The training suggested by this analysis is likely to contribute to operational readiness:

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Little	Some	Much	Extensive
contribution to	contribution to	contribution to	contribution to	contribution to
readiness	readiness	readiness	readiness	readiness

Examples and Comments:

12. The analysis provides a clear link between suggested training activities (FTX, force-on-force etc.) and the unit level:

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activities	Activities	Activities	Activities	Activities
not at all	weakly	somewhat	strongly	completely
linked to unit	linked to unit	linked to unit	linked to unit	linked to unit
level	level	level	level	level

Examples and Comments:

13. The analysis provides tools and instruments to gather data about trainee performance:

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Few	Some	Many	Comprehensive
tools	tools	tools	tools	tools

Examples and Comments:

14. The analysis, its tools and instruments are sufficient to provide guidance on amending and improving the training program:

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not at all	Weakly	Somewhat	Mostly	Entirely
sufficient	sufficient	sufficient	sufficient	sufficient

Examples and Comments:

Overall document ratings

Based on my exploration, overall I would say the output document...

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. was clear and understandable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. was easy to navigate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. needed no further explanation or support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. contained meaningful information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. contained the right amount of information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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List of symbols/abbreviations/acronyms/initialisms

AAR	air-to-air refuelling
AFTEMS	Air Force Training and Education Management System
ALIC	Air Land Integration Cell
ASAT	Army Systems Approach to Training
ASUW	anti-surface warfare
ASW	antisubmarine warfare
C2	command and control
CAF	Canadian Armed Forces
CADTC	Canadian Army Doctrine and Training Centre
CAS	close air support
CFITES	Canadian Forces Individual Training and Education System
COMMAND	Comprehensive Mission Needs Analysis and Determination
DAST	Directorate of Air Simulation and Training
DCA	defensive counter-air
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DSTKIM	Director Science and Technology Knowledge and Information Management
FAC	Forward Air Controller
IMINT	imagery intelligence
JTAC	Joint Terminal Attack Controller
KSA	Knowledge, Skills and Abilities
LVC	live, virtual and constructive
M&S	modeling and simulation
MEC	Mission Essential Competency
OCA	offensive counter-air operation
QS	Qualification Standard
QSWB	Qualification Standard Writing Board
R&D	Research & Development
RAP	recognized air picture
RCAF	Royal Canadian Air Force

SAR	search and rescue
SIGINT	signals intelligence
SME	subject matter expert
TACP	Tactical Air Control Party
TP	Training Plan
TTP	tactics, techniques, procedures

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The Director of Air Simulation and Training has set an ambitious target of 2025 for developing a simulation-first training strategy for the Royal Canadian Air Force (RCAF). To meet that objective, training needs analysis methods must be applied to highlight current gaps in training with respect to simulation-based instruction and collective training in a synthetic environment. The training needs analysis components of the Canadian Forces Individual Training and Education System (CFITES) and the Mission Essential Competency (MEC) method were compared with respect to their ability to address client-identified gaps from the Simulation Strategy. Using those scales, expert raters provided their judgement on the compliance of each method to thirteen criteria in five categories: links with strategic guidance; simulation and media use, collective training, tools for trainee assessment, and usability. Both methods performed poorly against the criteria, however the CFITES method was judged as providing better tools for assessing trainee learning and improvements to training, while the MEC method was judged as providing better opportunities to develop operational readiness in the trainees. The failure to promote simulation-based options for training may be a result of a lack of top-down guidance with respect to such a strategy, or possibly a consequence of guiding subject matter experts who do not fully appreciate the potential of simulation-based training. The lack of collective training in the simulated environment might be a consequence of role definitions which do not *ab initio* include a concept of interdependence with other roles.

Le Directeur – Simulation et instruction (Air) s’est fixé l’objectif ambitieux d’élaborer une stratégie d’instruction axée principalement sur la simulation pour l’Aviation royale canadienne (ARC) d’ici 2025. Pour y parvenir, il faudra analyser les besoins en matière d’instruction afin de cerner les lacunes existantes relativement à l’instruction axée sur la simulation et l’instruction collective en environnement synthétique. Nous avons comparé la méthode d’analyse des besoins du Système d’instruction individuelle et d’éducation des Forces canadiennes (SIIEFC) et la méthode des compétences essentielles à la mission (CEM) en ce qui a trait à leur capacité de corriger les failles décelées par les clients dans la stratégie de simulation. À partir des données recueillies, des experts ont évalué la conformité de chaque méthode en se basant sur treize critères répartis dans cinq catégories, à savoir : les liens avec les directives stratégiques, l’application à la simulation et aux médias, l’instruction collective, les outils d’évaluation des stagiaires et la convivialité. En regard des critères utilisés, les deux méthodes se sont révélées peu efficaces; cependant, on a jugé que la méthode du SIIEFC offrait les meilleurs outils pour évaluer l’apprentissage des stagiaires et les améliorations apportées à l’instruction, tandis que la méthode CEM offre de meilleures occasions de développer la préparation opérationnelle des stagiaires. L’impopularité des solutions d’instruction axées sur la simulation est peut-être attribuable à l’absence de directives descendantes ou encore au fait que leur potentiel ne soit pas tout à fait reconnu par les experts en la matière. L’inexistence de l’instruction collective en environnement de simulation est peut-être une conséquence d’une définition des rôles qui ne prévoit pas *ab initio* une interdépendance avec d’autres rôles.

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Simulation-based training; Collective Training; Education; Needs Analysis; ADDIE; CFITES; Mission Essential Competencies.