The Implementation of Canadian Forces Individual Training and Education System and Mission Essential Competency Training Analysis Methods

A Case Study

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IMPORTANT INFORMATIVE STATEMENTS

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Abstract

The distributed and interdependent nature of modern armed conflict requires militaries that can function in collective environments. Given the considerable cost of training it is important to train the right people to do the right job in the right way. In developing its strategy to use distributed simulation to provide aircrew with collective training, the Royal Canadian Air Force (RCAF) questioned whether its training analysis method could be improved not just for individuals but in the context of teams and teams of teams. Currently the RCAF uses the Canadian Forces Individual Training and Education System (CFITES) to determine and address gaps in training; however, other models of analysis might better perform this same function. Training needs for the Joint Terminal Attack Controller (JTAC) have previously been analyzed using CFITES, and more recently using a different method, the Mission Essential Competency (MEC), used by Canada's closest ally, the United States. These parallel analyses allowed an exploration of differences and points of intersection between the systems, as well as possible opportunities to exploit the strengths of each system. This paper examines the characteristics of the two methods and examines their application to JTAC training, noting process inputs and outputs, strengths and limitations. Our analysis suggested that CFITES addresses considerably more aspects of training with greater flexibility than MEC; however the MEC analysis process offers excellent output for structuring training, particularly with respect to operationally contextualized and collective performance. By adopting the MEC as a particular kind of analysis within the broader scope of CFITES it would be possible to derive significant benefits offered by the MEC method within the larger framework provided by CFITES.

Significance to Defence and Security

This assessment examines the merits and limitations of two current training need analysis (TNA) methods, one currently in use by Canada, and one currently in use by our closest ally, the United States. Both methods have been recently applied to JTAC training. Selection of the most suitable TNA method could improve efficiencies in training and enhance combat effectiveness, and could also improve interoperability of training and operations in coalition contexts.

Résumé

Le fait que les conflits armés modernes peuvent être, de par leur nature, tant disséminés qu'interdépendants exige que les militaires puissent fonctionner dans des environnements où ils sont appelés à travailler collectivement. Étant donné le coût élevé de la formation, il est important d'instruire les bonnes personnes pour effectuer le bon travail de la bonne façon. Lorsqu'elle a élaboré sa stratégie d'utilisation de la simulation répartie pour dispenser une formation collective à ses équipages d'aéronefs, l'Aviation royale canadienne (ARC) s'est demandé si sa méthode d'analyse de la formation pouvait être améliorée non seulement pour les individus, mais aussi dans le cadre d'équipes et d'équipes d'équipes. À l'heure actuelle, l'ARC utilise le Système de l'instruction individuelle et de l'éducation des Forces canadiennes (SIIEFC) pour cerner et combler les lacunes en matière de formation; cependant, d'autres modèles d'analyse pourraient mieux exécuter cette même fonction. Les besoins en formation du contrôleur interarmées de la finale de l'attaque (CIFA) avaient été analysés précédemment au moyen du SIIEFC, et plus récemment à l'aide d'une méthode différente, celle des compétences essentielles à la mission (CEM), qu'utilise le plus proche allié du Canada, les États-Unis. Ces analyses parallèles ont permis l'exploration des différences et des points d'intersection des systèmes, de même que la possibilité d'exploiter les forces de chaque système. Le présent document traite des caractéristiques des deux méthodes, de même que de leur application à la formation des CIFA, en observant les intrants et les extrants des processus, ainsi que leurs forces et leurs limites. Selon notre analyse, le SIIEFC couvre considérablement plus d'aspects de la formation avec une plus grande flexibilité que les CEM; toutefois, le processus d'analyse des CEM offre d'excellents résultats pour la structuration de la formation, notamment en ce qui a trait à la performance opérationnelle contextualisée et collective. En adoptant les CEM en tant que type particulier d'analyse dans le cadre plus vaste du SIIEFC, il serait possible d'en tirer des avantages considérables.

Importance pour la défense et la sécurité

Cette évaluation porte sur les mérites et les limites de deux méthodes actuelles d'analyse des besoins en formation (ABF), l'une maintenant en usage au Canada, et l'autre chez notre plus proche allié, les États Unis. Les deux méthodes ont récemment été appliquées à la formation des CIFA. Le choix de la méthode d'ABF qui convient le mieux pourrait améliorer l'efficience de la formation et accroître l'efficacité au combat, de même que bonifier l'interopérabilité de la formation et des opérations dans le cadre de coalitions.

Table of Contents

List of Figures

Acknowledgements

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1 Introduction

Military organizations train on a regular basis because training strongly influences combat performance (Deitchman, 1990; Gorman, 1990). In particular, militaries engage in collective training (Fletcher & Chatelier, 2000), "the mechanism by which a commander takes a full complement of qualified soldiers and, with time, resources and applied doctrine and standards, produces cohesive combat-capable tactical groupings" (National Defence, 2001, p. 59). Collective training is necessary because military operations are performed by organized groups of people and because team training provides specific benefits to team performance (Fletcher & Chatelier, 2000; Salas et al., 2008). Collective training requires significant time and funding, with Canada's Department of National Defence allocating $488M in 2015 for collective training to enhance interoperability amongst force elements. In a context of scarce resources, it is therefore important that the training needs analysis (TNA) method driving collective training be the best available. A training needs assessment or needs analysis is the practice of examining the overall objectives and needs of an organization and determining whether any shortcomings might be best addressed by training (Arthur, Bennett, Edens, & Bell, 2003). As a case in point, the Royal Canadian Air Force has questioned whether there is a superior alternative to the Canadian Forces Individual Training and Education System (CFITES) methodology (National Defence, 2003a) for guiding its future collective training (Royal Canadian Air Force 2014a). This report responds to that question, examining one contemporary method, Mission Essential Competencies (Colegrove & Bennett, 2006), and its possible relationship to CFITES.

Collective task analysis, training analysis and related methods are now understood as fundamental to scientific approaches to training, whereby these analyses generate hypotheses about the best possible training approaches, which are then systematically developed, tested and revised. Early analysis methods addressed readily observable tasks that emphasized motor skills, but later techniques addressed cognition and more abstract conceptions of work (Clark & Estes, 1996). This evolution also included a recognition that although learning is an individual phenomenon, there are differences between individual and team tasks, leading to new theories of team training involving competencies, shared mental models, and coordination (Cannon-Bowers & Salas, 1998; Kozlowski & Ilgen, 2006; Salas & Cannon-Bowers, 2001)

A recent example of this evolution emerged from United Kingdom's Royal Navy belief that the complex training requirements associated with its new aircraft carriers demanded a better treatment of collective training needs than was obtained from the UK Ministry of Defence's approach to individual training, education, and skills (Pike & Huddlestone, 2011). Accordingly, the Royal Navy sponsored the development of the Team and Collective Training Needs Analysis (TCTNA) method which is based on team and collective task analysis (Huddlestone & Pike, 2009, 2014). Another example is the United States Air Force (USAF) driving development of the Mission Essential Competency (MEC) method, which is structured around the performance of missions as part of a collective in the presence of an adversary (Alliger, Beard, Bennett, Colegrove, & Garrity, 2007; Colegrove & Bennett, 2006).

To respond to the RCAF question, MEC was selected as a contrasting method to CFITES. The selection was driven by opportunity and commonality, and not as a prejudgement of the superiority of MEC. The opportunity for comparison was a coalition application of MEC to Joint Terminal Attack Controllers (JTACs), which allowed direct comparison with JTAC analyses

conducted within the CFITES framework. The selection of MEC was also driven by the fact that it is used by the USAF. Commonality in training analysis methods with the RCAF's closest partner air force would increase the ability to share resources, harmonize training, and promote interoperability. Other approaches, such as the TCTNA, are also worthy of consideration and will be considered in a future review.

If an organization contemplates adopting different approaches for the analysis of individual and collective tasks, then the implications of using two different methods in parallel are worth considering. Parallel use of two methods could potentially lead to contradictory, independent, or reinforcing training approaches, which could increase or decrease the time and money required for the training analysis and the training itself. Similarly, if the training organization adopts an analytical method that simultaneously addresses individual and collective tasks, the implications of migrating from the legacy training approaches to the new one should be understood. Given that the RCAF is considering whether a new training approach is required, this report also examines the relationship between CFITES and MEC with the goal of understanding whether one system should be chosen over the other, as well as their possible interoperability.

2 The Canadian Forces Individual Training and Education System (CFITES)

2.1 A Brief History and Overview of the Canadian Forces Individual Training and Education System

2.1.1 Early Training in the Canadian Military

Within the Canadian Military context and prior to the mass mobilizations of World War I and II, training design and execution followed models that had been adopted from the British Army and (post 1905) the Royal Canadian Navy (RCN). The process of development and execution of training shared characteristics in common with the vocational educational practices accepted for use in the United States prior to the turn of the twentieth century (Giordano, 2005). These practices were based on a combination of individual subject expertise on the part of the individual designing training, on the extent of the related field of knowledge, and on any overriding policy in force at the time, some of which was derived from practices in instructional development common to teacher's colleges (Schrock, 1995). Production of trained soldiers was based on the "Depot model", which involved soldiers being immersed in the garrison environment (Grant, 1996; Hooker, 1996). This involved a methodology of "learn by example" and practice (Schank, Berman, & Macpherson, 1999), being initially instructed in and subsequently drilling the initially simple and increasingly complex tasks expected of soldiers at their respective rank levels. This approach dates to the practices of the Roman Army (Grant, 1996; Hooker, 1996). This apprenticeship model was also followed by the RCN, which used shore-based installations to conduct some aspects of Officer, Petty Officer and Rating technical training. In each case, training occurred at a location capable of supporting training, and in each instance of training a group, a common-to-branch of service curriculum was applied, based on a central authority.

The numbers of trained personnel required for World War I, along with changes in technology and approaches to warfare drove changes to the process of training for the Canadian Expeditionary Force and nascent RCN. Selection of suitable recruits for roles and subsequent training at Regimental Home Stations was scaled up to take place in larger numbers at Training Camps, and available technologies, such as the initial use of Edison's "moving pictures" (Brooker, 1947; Carter, 1919; Hoban Jr & Van Ormer, 1950) and very basic simulation devices (Rolfe & Staples, 1986), were used as tools to support the process of learning and accelerate training in preparation for deployment overseas. The increased use of mechanization in warfare resulted in the need to provide increasing levels of technical support, and a related requirement to train and assess within military training establishments. Specific examples of this were the repair and operation of trucks, the first armoured fighting vehicles, steam powered warships, submarines, and the various fixed wing aircraft of the Royal Flying Corps (later Royal Air Force and Royal Canadian Air Force). Together, the increase in numbers of personnel to be trained and the impact of changes in technologies used drove military training establishments to provide more personnel at a more accelerated rate and wider variety of content than had ever been required before. Despite the shift in content, the practices of designing and delivering training were essentially the same—content was designed and delivered by either subject matter experts (SMEs) (McCall, 1922; Rolfe & Staples, 1986; Tyler, Madaus, & Stufflebeam, 1989) or military

members, generally with operational experience, who had themselves been trained to at least the level of the new students. (His Majesty's Stationary Office, 1932).

Based in part on a dissatisfaction with traditional, expert-driven approaches to content development and curriculum design within American school systems dating back to the 1920s, a more structured and systematic approach to the design of educational materials was developed. This approach formalized philosophical practices that had been used to varying degrees in the United States and Commonwealth countries (Bruner, 1966; Schrock, 1995). Described as Instructional Design (ID), the approach promoted a standardized approach to designing educational content. Focusing on specific subjects, it provided a methodology to SMEs, and yielded a higher degree of success in creating logical, sequential and audience appropriate content in specific subject areas (Molenda, 2003). The ID model, however, was insufficient for the larger problem of teaching content that was multidisciplinary in nature. Recognition of this problem eventually resulted in Instructional Systems Design (ISD, also called Instructional Systems *Development*). ISD was intended to address the needs of analyzing, planning, structuring and delivering technical content for ensembles of systems, and for creating coordinated, complex programs of instruction within US military organizations (Branson, Rayner, Cox, Furman, & King, 1975). The ISD model borrowed heavily from Behaviourist psychology and was developed to ensure the availability of effective, efficient and economical training to address all requisite aspects of the tasks that were expected to be performed by servicemen (Branson et al., 1975) This was particularly important during the mid to late 1970s as the equipment being operated was becoming increasingly complex while at the same time the initial educational level of potential operators was either unchanging or actually falling (Molenda, 2003; Molenda, Reigeluth, & Nelson, 2003). The unique aspect of the ISD approach was that it permitted planning in detail for training well-defined, specific task performances and the requisite, related knowledge for job performance. It focused on the simplest possible building block—observable, measureable task performances (written as short, simple sentences with a subject, and object and a verb) with clearly identifiable beginning and end points.

ISD methodology for developing educational materials was at odds with traditional approaches to education and training, which depended on the input of expert derived specialist knowledge and which did not commonly contain the checks and balances provided through the influence of a systems approach. Unlike either traditional, ad-hoc or ID approaches, ISD addressed the task of developing training and educational material as a repeatable process as opposed to a unique event. Traditional approaches based on expert input alone and Instructional Design generally focused on analysis and design, and lacked the checks and balances and overall control of the ISD approach (van Merriënboer, 1997). ID imposed internal structure and solid methodology for content development in a specific area, but did not provide the sense of fit within a larger setting and linkages to other aspects of a multidisciplinary field of study.

2.1.2 ADDIE Models and Development of CFITES

During the early 1960s, variations on systematic approaches to ID began to appear in procedural models of instruction in higher education. One feature of the ISD approach is the deliberate application of the major processes of Analysis, Design, Development, Implementation and Evaluation (ADDIE, Figure 1) within the model, causing the terms ISD and ADDIE to be nearly synonymous (Molenda et al., 2003).

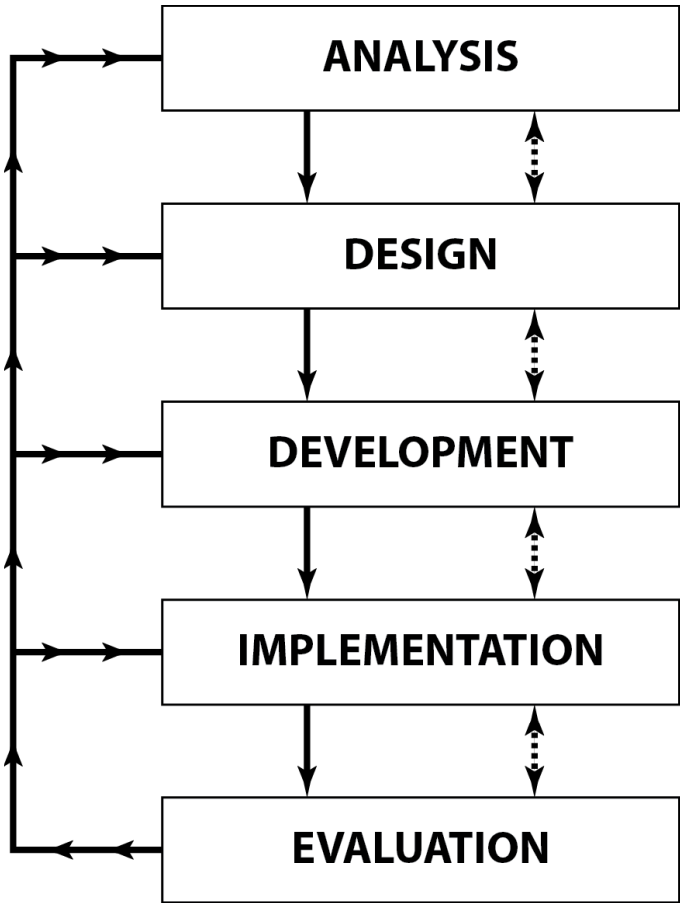

Figure 1: *Early model showing the ISD Process, adapted from Grafinger (1988).*

One ISD approach to creating instructional content was developed for the US Armed Forces at the Center for Educational Technology, Florida State University in 1975 (Branson et al., 1975). The approach was specifically oriented towards the use of behavioral/performance objectives and criterion-referenced tests (Watson, 1981). Following development, the model was subsequently adopted by the five US Armed Services. Each service made changes to the basic model by adding descriptions of element-specific administrative activities to suit their needs. At this writing, there are nine variations of the basic model in use by the five US Armed Services and four US civilian Defense Agencies.

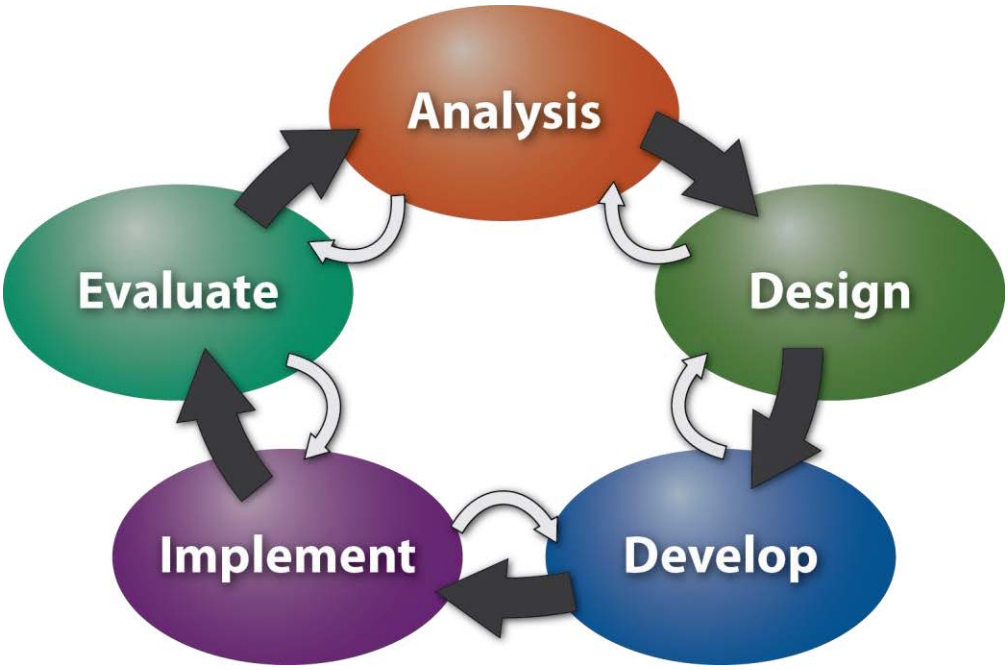

Figure 2: *Basic ADDIE model as adopted by the CAF in 1976. The process typically begins with Analysis. Black arrows indicate the direction of the process overall, and white arrows indicate that later phases can recursively inform and guide earlier phases in future iterations of the process.*

The variation of the ADDIE model used by the CAF was derived from a blend of Dick & Carey's work done between 1972 and 1978 (Dick & Carey, 1978; Dick, Carey, & Carey, 2013) and the 1975 United States Air Force Instructional Systems Design model, the least complex of the five ISD model variations adopted by the US Armed Forces. Like the previous versions of ADDIE, it can be described as a process model (Werner, DeSimone, & Harris, 2006). It was initially adopted by the CAF in 1976 (National Defence, 1998a) with the functions as shown in Figure 2 above, and is used as a methodological guide for developing training content at a variety of levels of complexity. This version emphasizes the iterative and cyclical nature of the process, as well as the influence of each stage on previous stages.

The Canadian version of the ADDIE model was originally termed the Canadian Forces Individual Training System (CFITS), but as the main focus within the CAF was broadened to include education, this process was retitled the Canadian Forces Individual Training and Education System (CFITES) (National Defence, 1998a). The Canadian Armed Forces have in turn modified the model slightly, splitting the Evaluation phase into Evaluation (focusing on evaluation of the student and efficacy of the training program with respect to student learning) and Validation (oriented to ensuring the training program meets the verifiable, current needs of the Armed Forces) as seen in Figure 3. As with other ADDIE model variants, it focuses on defining performance (as performance statements which describe discrete activities), but has at its root the perspective of the activity to be performed, which is used to associate relevant knowledge and skills and uses the set of definitions and methodologies to define task, knowledge and skill as set out by Mager (1997).

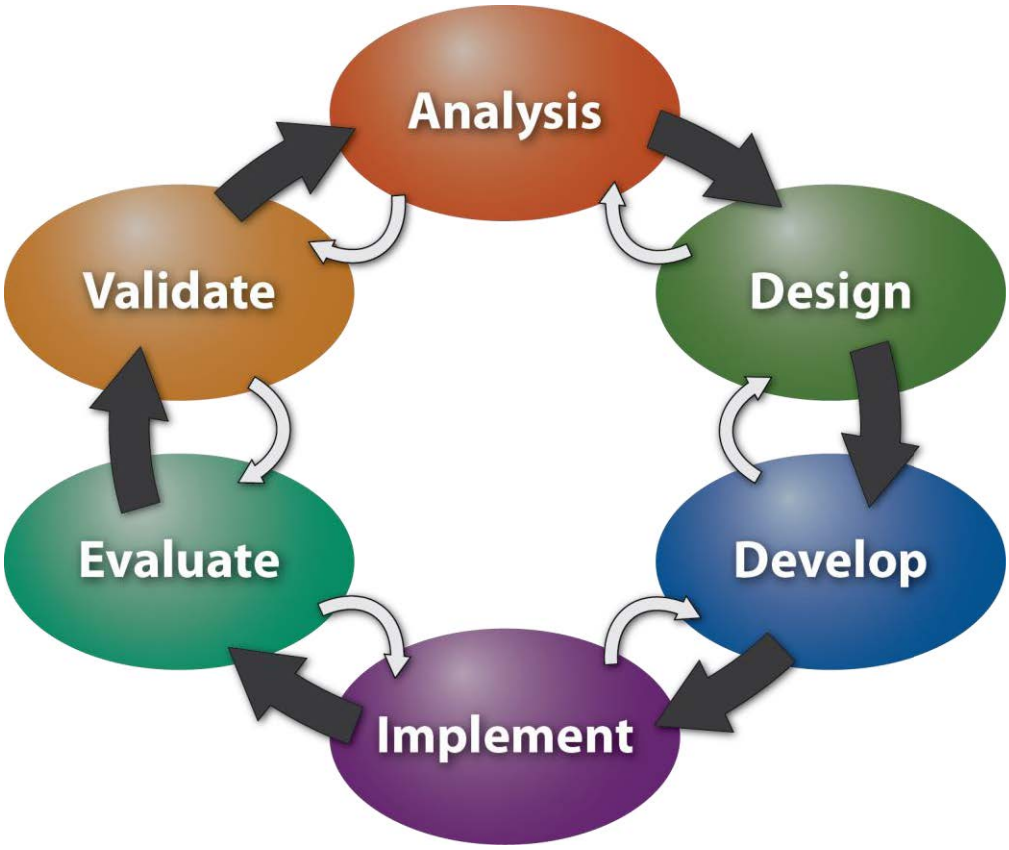

Figure 3: *CFITES process model, adapted from CFITES Volume 1 (National Defence, 1998a).*

The CFITES methodology as a process is applied for each element of a course or program of study, iterating through the cycle several times to ensure accuracy, appropriate level of detail, and linkage to related topic areas within the larger whole. Within the Canadian Armed Forces, this process is not applied rigidly, but addresses points between each major stage where the portion of training content under development is defined (based on identified need), developed, trialed, verified, and either retained as a working solution or abandoned as inappropriate, an approach supported by van Merriënboer (1997).

The initial focus of the CFITES process (as with any training process) was to prepare individuals to perform specified, individually-oriented activities, leading to qualification of individual personnel. However, the CFITES approach has also been successfully used for designing and delivering collective (crew) training. The difference in individual as opposed to collective training applications is in the actual performance statement—collective performance statements describe group activities (B. Dececchi, personal communication, March 23, 2016).

The use of the ISD-based CFITES model permits the existing training system to produce specific, user tailored outcomes in the form of measurable and identifiable procedures and products, which are based on identified user requirements. The products of this process within the CAF context are the detailed training and educational control documents for each military qualification, which specify the required task performance (what the individual shall be able to do), plus the supporting knowledge (what the member must know to be able to perform the identified activity

safely and in a professional, competent manner) and associated skills (such as proficiencies in the use of specific equipment or execution of clearly identified procedures). Following the considerable development of training models, CFITES is the methodology applied to individual training and education (IT&E) for all of the CAF.

2.1.3 Anticipated Evolution of CFITES

As training and education within the CAF have matured and developed, the supporting policy and practice has also changed. From the early "Depot Model" of WWI, to the creation of CFITS, to the inclusion of education with CFITES, the CAF has endeavoured to apply best practices based on research, experience, and lessons learned. The CAF is at present reviewing its training doctrine, with a new model anticipated in late 2016 or early 2017. Expected changes include a revision of the role of *individual* education, and an inclusion of collective training (B. Dececchi, personal communication, March 23, 2016). The coming changes to the Canadian training system are expected to clearly move training toward collective models that will have greater operational relevance and impact.

2.2 The CFITES Process

The CFITES process begins when a gap between performance and a minimum qualification standard (QS) has been identified by National Defence Headquarters (NDHQ) or the Training Authority over the QS in question. Such a gap may be revealed by a critical incident or failure, by the introduction of new equipment or technology, by the application of new policy or doctrine (National Defence, 1998b), or through combat experience. Because CFITES follows an extended ADDIE structure, the process can be best understood through descriptions of the Analysis, Design, Development, Implementation (often called 'Conduct' in the CAF), Evaluation, and Validation phases.

The Analysis phase subjects the perceived problem to a detailed Needs Assessment; a documented, logically sequenced data collection and analysis process including resultant conclusions and recommendations in order to fully examine a problem or issue before selecting a solution. The purpose of the Analysis phase is to ascertain the specific performance objectives or education objectives required to meet the specified outcomes. The products of this phase are a Needs Assessment Report (which includes a description of the tasks, skills and knowledge required for job performance) and a Specification for the role being examined. Each Specification is a detailed list of the tasks to be trained to meet the CAF's requirements at the time of the analysis. This may be either a completely new area or a revision of existing material.

In the Design phase, QSs are developed from the relevant Specifications. These QSs are legal job descriptions that include the tasks, knowledge and skills as well as standards of performance required by the graduate of the training in order to achieve operational proficiency in the role to be trained. These are described along with the conditions under which they must be able to be performed, what resources he or she will have available, where the task is expected to be performed and any specific limitations. Developed QS drive the next phase of activity. (National Defence, 1998b, 2003a).

In the Development phase of CFITES an IT&E event and instructional strategy is selected to enable the learner to achieve the performance objectives. (National Defence, 1998c). The QS is expanded into a training plan (TP), which is a detailed curriculum that reiterates the QS identification of several performance objectives (POs) required to perform the job and subsidiary enabling objectives (EOs) required to achieve each PO. The TP includes detailed set of lessons to address each PO and EO including the contents of each lesson, a detailed timetable, test plans and assessment guides for materials, and instructions on resources required for each period of instruction (National Defence, 2002).

The Conduct (Implement) phase is the point at which the material identified in the QS and developed in the TP is delivered to the student. Here the learners acquire the skills, knowledge and attitudes that they need to achieve the prescribed objectives (National Defence, 2002). During this phase, adjustments may be made to examples used or specific content for the sake of currency and accuracy (and which is documented as part of the constant Quality Assurance process in CAF Training Establishments).

In the Evaluation[1] phase, students are formally assessed against the benchmarks for performance as described in the TP. Within the CAF system, this is essentially a pass/fail (criterion-referenced evaluation) as opposed to letter graded (norm-referenced evaluation) process, as much of CAF training is essentially done using a Vocational School approach. The Evaluation phase ascertains whether or not the instruction has been effective and efficient (National Defence, 1998e). These duties are undertaken by the Qualification Standards' Board which is comprised of the office of primary interest OPI, SMEs, and the supporting Training Development Officer or delegate.

Finally, within the Validation phase, the benchmarks from the QS and the contents of the TP are compared to the real world occupation, and determination is made as to whether the training meets job requirements or not. The validation is the responsibility of the Managing Authority, an agency appointed to oversee assigned IT&E programmes: this could include the Training Authority or the Designated Training Authority. This phase includes routine checks to provide moderate assurance of efficiency and minor course correction during the life cycle of a programme of instruction; comprehensive reviews, sampling from many data sources aimed at overall programme efficacy and revision; or focused reviews on a particular aspect of a programme of instruction in response to a known issue. Both qualitative and quantitative data are gathered through surveys, questionnaires and interviews, as well as observations applied to checklists and purpose-made testing instruments. Validation occurs after the learner has returned to the workplace, and verifies that the IT&E programme has prepared its graduates to perform the operational tasks or achieve the professional competencies that were the stated outcomes of the training programme (National Defence, 1998f). If not, shortfalls are reported in the form of a Validation Report, which feeds the process of Needs Assessment in the cycle of Quality Assurance in training. The Validation phase is undertaken by the QS owner within six months of the completion of any training. All QS are to be validated every five years.

[1] In the context of Canadian Army training doctrine, "Evaluation" refers to measurement of the effective and efficient delivery of training in a manner that eliminates a given training gap, identified as such through the analysis process. For this, the appropriate unit of measure is the course of study: *Did the course address the gap?* Evaluation of learning within a course also requires assessment of learners to determine success of individual students: *Did the student learn the material?* With respect to the discussion of CFITES throughout this document, the term "Evaluation" may be applied to both course evaluation or student assessment.

The Quantity Control Process aims to provide IT&E to for the right people at the right time for the right cost. Within the Quantity Control process the management functions supporting basic qualification and non-basic qualifications monitor the provision of IT&E identifying individuals, or numbers of personnel who require qualifications or competencies to perform on the job. The Resource Management mechanism in CFITES operates to improve resource-effectiveness linking IT&E with Business Planning (National Defence, 2003a).

2.3 The CFITES Approach in Practice

Officially since 1997, the CFITES approach exclusively has been used within the CAF to address gaps that have been identified as best modifiable by training (National Defence, 1998a), succeeding the CFITS model. The approach, by its very definition and description, includes provision for careful documentation and data collection, analysis of results, revision of materials and methods, and a progressive development of instructional practice through successive instances of the method (National Defence, 1998a, 1998b). In other words, as described in its manuals, CFITES is a process of reflective and progressive iteration based on testing and documentation, and should generate considerable data for analysis, interpretation and action. The CAF currently has 84 occupational roles across 3 service environments (National Defence, 2016), each of which is anticipated to generate respective QS and TP documents. Although the level of effectiveness for military training and operations is strategically sensitive, anecdotally, CAF troops are considered to be well-trained and effective by international combat colleagues.

Although the elements of CFITES (analysis, design, development, implementation, evaluation and validation) are applied *consistently* for the generation of all training and education programs, they are not applied *uniformly* across the diverse, multi-element training requirements of the CAF. That is, all parts of the process are fully used, but their use is adapted to each particular situation. The system was specifically structured with flexibility in mind, to meet the specific requirements of a given school (National Defence, 2003c). This adaptability permits CFITES' application to the training of procedural skills, for example with respect to infantry (National Defence, 2010), or to the teaching of concepts and knowledge, for example in a course for officers (Scoppio & Smith, 2002). Similarly, while the CFITES process is most typically applied to individual training, there are instances in which it has been applied to collective training, for example for Joint Force operational planning and force development (C. Huffam, personal communication, April 20, 2016). Overall, this flexibility is a strength in a small military where it would be impractical to develop a purpose-built training analysis system for each scenario. At times however, a lack of uniformity may lead to lapses. Below, we investigated known examples of such lapses within CFITES to grasp what impact they might have on the system as a whole.

As a matter of doctrine, CFITES is used as the means to assess training needs and to respond to those needs through the design, development, implementation, evaluation and validation of appropriate training programs. However, there has been no overall exploration of the doctrinal fidelity with which any of the steps in the process have been followed within the CAF, nor to what extent data has been collected, analyzed and acted upon for validation and evaluation of training programs. As an important example, a Master's thesis documented that as late as 2015, the rotary wing Flight Instructor Course at 406 Maritime Operational Training Squadron did not have a TP (Mann, 2015), showing that adherence to the CFITES process is not complete, even for very important 'train the trainer' courses. Moreover, an audit of the Air Force Training and

Education Management System (AFTEMS), an elaboration of CFITES, revealed that 18% of 1st Canadian Air Division and 47% of 2nd Canadian Air Division courses required development or revision of QS documents (MacDonald, 2012). This may be a matter of a lack of sufficient review personnel rather than shortcomings in the system itself.

In the open literature, there are very few studies exploring CFITES from a scientific standpoint, however validation of courses has been explored under the previous Canadian Forces Individual Training System (CFITS), with more than 120 course validations taking place at the CF Combat Training Centre in Gagetown during a 5 year span (Scoppio, 2003). Further, the scientific development of a validation methodology and strategy within CFITES has been explored.

The *International Handbook of Education for the Changing World of Work* features a chapter on educational programme validation. The chapter reviews research on the CFITES validation approach in the context of several other methods and observes that as written, CFITES does not adequately allow for validation of educational programs in comparison with training programs (Scoppio, 2009). Recommendations based on earlier research on officer education (Scoppio, 2003; Scoppio & Smith, 2002) include the importance of exploratory studies to include knowledge and intellectual competency, reliable technology to gather data, and high quality reports based on best practices for report writing (Scoppio, 2003, 2009; Scoppio & Smith, 2002). It should be noted these reports and monographs are not peer reviewed, although the authors are respected authorities in military education.

For a validation instrument, the CFITES manual on Evaluation of Instructional Programs recommends the Kirkpatrick Evaluation Model (National Defence, 2003b). The model has four 'levels': Reaction (how the students felt about the training); Learning (change in knowledge or skills as a result of the training); Behaviour (change in workplace performance of the trainee as a result of the training); and Results (benefit to the goals of the organization as a result of the training) (Kirkpatrick, 1979). The data collection section of the manual recommends examining existing evaluation and validation reports, as well as interviews and scaled response questionnaires to obtain instructor and student self-appraisals of their feelings, attitudes and opinions about the importance and efficacy of the course. This corresponds to Kirkpatrick Level 1 analysis (*reaction*), but does not address the three increasingly important steps in the hierarchy, specifically *learning, behaviour* and *results* (Alliger & Janak, 1989). Pass/fail rates and attrition rates are mentioned in a section on trend analysis, however there are very few objective evaluative measures recommended (National Defence, 2003b). If consideration of pass/fail rates is included, Kirkpatrick's Level 2 is addressed by the Evaluation of Instructional Programs. Levels 3 and 4 (Behaviour and Results) are intended features of Validation in CFITES (Scoppio, Idzenga, Landry, & Miklas, 2008). Proper Validation is a critical component of CFITES, however appropriate application of this phase was not evident in superseding QS documents. In the Tactical Air Control Party (TACP) QSs for 2012, no mention is made of any validation analysis or report (National Defence, 2012b, 2012c).

Similarly, other important aspects of CFITES have at times been omitted. One Master's thesis examined the use of CFITES for maritime helicopter flight instructor training (Mann, 2015). After-action reporting of a hard landing as a result of engine failure during training revealed the instructor was relatively junior and inexperienced with emergency procedures. Further he had not completed training on how to instruct for this particular emergency. The researcher found there

was no TP for the Flight Instructor Course (FIC TP) for this particular squadron. The failure to appropriately apply CFITES was not noticed through audit or oversight.

Through the research, Mann performed an Analysis of Instructional Requirements, identifying performance gaps and creating an FIC TP. For the needs analysis, Mann followed the prescribed steps of CFITES, but also integrated principles from other literature, notably work by Saks, Haccoun and Belcourt on performance management (2010) which includes a distinction between task analysis and a 'person analysis' which looks at performance on an individual by individual basis. Importantly, subject-matter expert (SME) flight instructors were included for the development of a TP to meet a pre-existing QS (Mann, 2015).

When the Analysis was applied, care was taken to align both the process and the product with the CFITES requirements. A Training Development Officer (TDO) from the Wing participated fully in the development workshop, and spent considerable time afterward refining the materials with respect to doctrine (D. Mann, personal communication, October, 01 2015). In this instance, although an important document was missing, CFITES provided a structure to address the problem.

2.4 Summary

CFITES is an evolution of the ADDIE model. It features the additional phase of Validation of the model, thus ensuring the applicability of training *and* education, providing the correct learning opportunity to the correct people at the correct time. The specific steps of CFITES provide an iterative, progressive means of developing, assessing, and revising training programs to overcome training-related performance gaps, however there are occasional deficiencies in its application such as missed phases or poor interpretation or execution of phases. These lapses could be expected with any large and complex process; however careful adherence to the system and monitoring of the practices could lead to improved training. Historically, the system was developed for individual training, but lacks specific and validated methods for addressing collective training issues.

3 The Mission Essential Competencies Approach

3.1 A Brief History and Overview of Mission Essential Competencies

The MEC model shares most of its history with the ID and ISD models up until the early 1970s and can be found in Section 2.1.1. It emerges from a historical context of job analysis, a practice that began with the scientific exploration of work in Europe as well as Taylor's scientific approach to management (Alliger et al., 2007). This type of systematic observation typically takes the course of either an enumeration of the activities of the job, or an exploration of the necessary education, and skills, knowledge and attitudes required for success in the job.

In 1973, McClelland observed that success in a given job does not necessarily correlate with intelligence test scores, but rather capacity with respect to specific job-defining skills, knowledge and attitudes. These "competencies" should be testable and trainable: that is, any tests for suitability to a given role should measure the criteria for success in the role, but also provide meaningful targets in training individuals for future on-the-job success (McClelland, 1973). This initial competency construct has been further developed and refined.

Competencies have three defining characteristics: they are necessary to successfully complete the task; they allow for comparison between novice and expert; and they are measurable and observable (Catano, 1998) in a way that is agreed upon by independent raters (Alliger, Beard, Bennett, Symons, & Colegrove, 2013). Competencies are general criteria for success on a job, amalgamating requisite skills, knowledge or attitudes into higher level functional behaviours. They also describe outcomes that are related to the overall goals and objectives of the organization. Like instructional systems design described in the previous section, competency approaches also use performance statements, and the structure of the activity or statement is more or less interchangeable with that of the ISD approach. Importantly however, in a competency approach the performance statements address the capacities of the individual in the role. Kerry states that while competency models promise much they rarely deliver the benefits their proponents claim for such diverse reasons as lack of human or financial resources, agreement on the definition of competency, insufficient staff with skills needed to implement the model, or top-down approaches that ignore the expertise of the end-user. In addition, traditional competency models are complex to develop and difficult to apply effectively across an organisation (Kerry, 2013).

While the competency approach may have represented an improvement over previous methods (Spencer & Spencer, 1993), analyses of the gaps between required skills and the provided training revealed that more focused training was needed to address the various exigencies of a given role in a given mission. In 2000, Distributed Mission Training was presented as a model which allowed trainees to develop skills both as individuals and as members of a team (Bennett, Crane, & Tucker, 2000). The authors of the report observed that development of flight missions requiring high performance necessitated a corresponding development of "mission essential competencies" or MECs. The MEC is distinct, in that it identifies a set of complex or clustered behaviours necessary to accomplish one aspect of a combat role and is defined as a "higher-order individual, team, and inter-team competency that a fully prepared pilot, crew, flight, operator, or

team requires for successful mission completion under adverse conditions and in a non-permissive environment." (Alliger et al., 2013, p. 119). Importantly in this definition, the necessary job-specific skills, knowledge and attitudes are available under stress, underscoring the military context of these competencies.

MEC aims at the mid-ground in job analysis. They combine descriptions of the job that needs to be done in a given context, with the skills, knowledge and attitudes necessary for its accomplishment. In this instance, attitudes or characteristics needed by a trainee to complete them mission are called *supporting competencies* (SCs) (Alliger et al., 2007). In this way MECs are more detailed than the highest-level descriptions such as the US Air Force Universal Task List and Mission Essential Task Lists, but more abstract than lower-level training tasks lists (Figure 4) (Bennett, Alliger, Colegrove, Garrity, & Beard, 2013). In this way MECs provide a measurable, definable performance criterion without specifying the exact manner of executing each component of the task. This level of detail produces requirements that are likely to achieve the desired effect while allowing flexibility in the process. It is generally understood that some roles are relatively independent, for example a pilot, while others are interdependent, for example the seven roles in an Air Warning and Control System (AWACS) team. MECs are developed to consider areas of distinct and overlapping requirements for all roles. In this way the MEC suggests both what needs to be done in a specific context and what kind of person or group might best do it.

Figure 4: *An overview of MECs in relationship to other USAF specifications for work.*

The MEC method generates critical training experiences to develop the necessary trainee attributes, and also suggests whether a live, simulated or academic activity will be necessary to address a gap, as well as a means for determining the optimal mix of resource investment in

relationship to trainee proficiency (Bennett et al., 2013). Further, because new combinations of live, virtual, and constructive simulation are becoming available, with each permutation offering different training capabilities (Read & Woods, 2011), the analysis is intended to suggest an expert-derived "best" combination given finite resources and time. In this way the MEC method attempts to prepare the people with the greatest likelihood for success in the most economical way.

3.2 The MEC Process

MECs are brief, written statements that function both as a criterion for success and a tool for developing training strategies. As written, each MEC states the name of the MEC, a brief explanatory phrase if necessary, when the competency begins and ends with respect to a given aspect of a mission, and what the purpose of the MEC is. Some competencies follow sequentially one from the other in temporal order, while others may be performed in parallel, or asynchronously. The following is an example from the recently developed JTAC MEC analysis.

Build and Maintain Awareness of Theater and Area of Operations: Gather information on theater/AO, ROEs, contacts, personnel, agencies, experts, human terrain, and local area information; gain clarity on operational procedures (e.g., Joint and coalition), key personnel and liaisons.

Start: Pre-deployment

End: End of deployment

Purpose: Sets foundation for operations/employment within specific theater/AO

The process for generation of MECs for a given role follows a careful progression of two focused workshops with SMEs and facilitator/analysts, then a survey exploration of the broader population in the role, and finally, a formalization of the MECs based on a third workshop with SMEs. Because of workshop timing, not all SMEs participate in all workshops.

The first workshop reviews the parameters of a given mission, considers the structure of the work environment and tasks for a given role in the mission, the knowledge and skills required for its completion, and then creates draft MECs. The personnel for this workshop includes two to five SMEs for each role being considered, in addition to the facilitators. The SMEs are members of the operational community with considerable experience in theatre, and often in a training role (G. Alliger, personal communication, May 26, 2015). The facilitators are individuals who have been fully trained in the conduct of MEC analysis. They need not be military experts—indeed it is desirable that their knowledge of military procedures is limited in order to ensure that issues that otherwise might be considered 'obvious' are fully explored—someone has to ask the 'dumb' questions. The MEC facilitator may be ignorant of prejudices and politics inherent in a given situation. This could be advantageous. Presuppositions held by SMEs may be exposed through the naïve questioning of the analyst.

A second workshop with the SMEs reviews and revises findings from the first workshop, explores the SCs and develops a more detailed and structured consideration of specific skills, and knowledge required. Finally, the participants elaborate the experiences needed to develop a

requisite knowledge or skill, or to practice a MEC or SC under operational conditions. This feature is important for proficiency-based training,

The next step is development of field surveys which are distributed to a broader sample of the population in question. Both experts and non-experts respond to questions about knowledge, skills, SCs, experiences, and learning environments proposed in the second workshop (Alliger et al., 2007). Some survey questions are the same for experts and non-experts, providing a means to examine internal validity, while the experts complete additional surveys about experiences that could be expected to develop a MEC, or about environments that might provide the necessary developmental experiences.

Typically, the responding members of the operational community are asked about their self-rated proficiency in the MEC on a 1–5 Likert scale. Because a MEC should be able to demonstrate differences between novice and expert, these self-assessments validate the MEC when experts rank themselves as "Ready to go" (5) or "I'm ready to go, however I'd like to get a little additional experience in this area" (4), and novices rate themselves lower, anywhere from "Not ready to go" (1), to "Ready to go" but would like substantial amount (2) or fair amount (3) of additional experience. It may be important to note that the first level of the scale ("not ready") represents a self-assessed cut-off below the basic qualification for the role. In other words, the anchor could equally describe a person who has never even heard of the role or someone who has received full training but does not feel ready.

Survey respondents are also asked to rate the utility of the developmental experiences for MEC training, how well one can obtain those experiences in particular training environments, their self-assessed knowledge and skills pertaining to the MEC, and frequency of the experiences in the *current* training environment.

Last, in a third workshop the survey results are interpreted by SMEs and facilitators. Demographics, self-assessed proficiency, and many other variables in the database are analyzed to identify training success, gaps and opportunities. In some instances population means and standard deviations are considered as well as the percentage of the respondents who answered in one way or another. A few of the measures are derived by proprietary formulae or processes. Some reliability and validity questions can also be answered from the database by inspecting the ability of the tool to distinguish between expert and novice, the extent of correlation between service years and expertise, the degree to which respondents from within the same team agree, etc. Armed with these results, trainers can provide a training program and offer an evidence based balance between live and virtual training. Specific prioritised training recommendations can be made that avoid unnecessary repetition and focus on addressing any gaps in what the combat soldier needs to be effective, while making optimum use of the available resources.

The MEC process generates several key products in addition to the competencies themselves: a list of the skills and knowledge necessary for a given role in a given context, and a list of experiences that are expected to develop those skills and knowledge. Further, there is a corresponding list showing the degree to which that item is *not* being addressed by current training as well as the level to which a given skill or knowledge is required for successful completion of the role. In other words, the tool shows whether there is a training gap and the priority for closing that gap. Additionally the instrument offers the determination by the operational community of whether schools, continuation training, small unit exercises, combined

arms / joint exercises / coalition exercises, simulators or combat ops, are preferred to provide the key training experience. In some instances the operators might suggest several training environments, however it may be seen as desirable to train a particular key experience in one or two environments, and difficult or impossible in others. For example, the key experience of "Time sensitive targeting" could be trained to some extent in all training environments, however "Participate in a dynamic ground maneuver live fire assault while controlling CAS by night" by definition, cannot be trained in a simulator.

The generated lists are derived from a complex spreadsheet with extensive inter-relationships and cross-references. The information can be organized to isolate a particular skill or knowledge and hence determine what key experiences might address the gap. Alternatively, the information can be organized by key experiences to determine all of the skills and knowledge that would be addressed in one opportunity. One other way the information can be organized allows the user to explore all key experiences exploited by each training environment. Equally, information can be sorted by importance to the role or by the gap priority.

Taken as a whole, the spreadsheet allows any trainer to select resources and training experiences to tailor specific learning opportunities for overcoming known gaps. However, the instrument does not explicitly dictate what mix of virtual and live training or what collection of experiences should be used to address all gaps. This allows for considerable flexibility within a given service or across allied nations to train to a common standard while recognizing differences in training opportunities, equipment and personnel.

A trainer might know, for example, that she will have access to a simulator for a limited period of time. While 'Military Symbology: Understand military map marking' is a knowledge item expected at an intermediate level of competence, it is not identified as a training gap, nor is a simulator needed to train the item. The trainer can instead focus on developing skills that for reasons of expense or safety are not typically practiced in live exercises, and for reasons of practicality cannot be practiced in the classroom. Further, the output data gives a detailed set of performance requirements that can be structured to assess learning outcomes and continued performance in the role (Bennett et al., 2013).

3.3 The MEC Approach in Practice

MECs have been used extensively within the United States Air Force. They debuted in 2000 at Nellis Air Force Base for air-to-air training in F-15 and F-16 jets (G. Alliger, personal communication, June 04, 2015). As of 2013, almost all Air Force roles in all missions—from combat pilots to surveillance operations, and civilian to military—have been characterised by MECs. Further, some coalition partners have used the process in other contexts (Bennett et al., 2013); it was introduced to the UK in 2003 under the Coalition Mission Training Research Project Agreement (The Technical Cooperation Program, 2003) and has since been applied by the UK team to over 20 Force Elements (H. Keirl, personal communication, October 29, 2016).

The reliability and internal consistency of MEC results have been studied in a meta-analysis. In keeping with McClelland's notion that success in a job should be linked with relevant knowledge and skills (McClelland, 1973), and Catano's notion that a competency should distinguish between novice and expert, and identify what an individual must learn to become more expert (Catano, 1998),

a recent study using psychometric measures has determined that MECs do in fact identify the requisite skills (Alliger et al., 2013). The work sampled a wide variety of survey data from many different iterations of the MEC process and compared inter-rater reliability using an interclass correlation analysis. Researchers found clear differences between expert and novice self-assessments of proficiency on probe items. They also found agreement of scores for determining the value or importance of a given training experience, and that knowledge and skills increased as a function of time on the job (Alliger et al., 2013). Perhaps two caveats are important when considering these conclusions. The first is that all measures of proficiency are self-derived, not measures of actual combat effectiveness or achievement of organizational goals and objectives. The second is that while it is common and valid for developers to investigate the reliability of their own process, ideally evidence from independent analyses would also be available.

The MEC method has been refined over time; new details have been included such as the formal development of links between the training experiences and the required knowledge and skills (G. Alliger, personal communication, June 11, 2015). Another evolution is the development of an expedited "starting deck" approach. Existing MECs for the F-16 block 40 jet design were used as a seed for MECs for the F-16 block 50 design, a craft which has improved GPS and advanced missile capacity over the block 40 variant. In this instance, already-existing results from the first two block 40 workshops were reviewed and edited based on the capabilities of the more advanced jet, and the survey and final workshop were developed in the normal way (G. Alliger, personal communication, June 11, 2015). Such a starting deck approach would not be appropriate with more significant changes to weaponry or command and control systems since the context-dependent knowledge and skills would also require adaptation.

The MEC process is resource intensive. MECs are developed over a long period of time using a considerable number of personnel. (see Section 6 for a detailed enumeration of MECs applied to JTAC training). More than 2000 work-hours were used in the development of those MECs, not including any hours for the preparation by the contractors, or the hours of analysis of the collected data, and the development of the JTAC MECs were considered typical.

3.4 Summary

The MEC method is a carefully prescribed type of work analysis developed by the United States Air Force Research Lab (USAFRL) and its contractors that employs facilitated workshops and self-report survey data from SMEs. From these inputs, knowledge, skills, supporting competencies, mission essential competencies, and developmental experiences are derived. It produces a richly interactive, interrelated data set that ties these concepts together with the current state of training in the target population and the perceived efficacy of potential training approaches.

The MEC method takes the operational mission as executed by the target audience as the context for the analysis. Given this focus and its emphasis on analysis and design, it addresses other aspects of the job and the other aspects of a systems approach to training only indirectly. For example, the choice of training as the means to address a performance deficiency is presupposed for the application of the method. MEC provides detailed insights into the training that is required along with recommendations of how to provide it, but does not include implementation of the training. As well, it provides content for the measurement and evaluation of training, but it does not provide the measures and standards.

4 Training Methodologies Applied to JTAC Training

While personnel on the ground have coordinated with attack aircraft for close support since the Second World War, and the Joint Terminal Attack Controller role was conceived and developed as recently as 2000, no attempt was made to standardize training for the role until 2002 (Armfield, 2003). Previous iterations of the role, such as Forward Air Controller, Airborne, Air Liaison Officers, Special Operations Terminal Attack Controllers and others have each developed training specific to their role (Armfield, 2003; Shand, 2008). The need for interoperability of the Terminal Attack Control position across service environments and among allies demands a measure of uniformity, thus requiring a standardized definition of the role and measures of qualification. Additionally, because of the smaller scale of the RCAF, tactical air control is frequently performed in support of coalition forces. These factors in turn necessitated a formal examination and analysis of the role (Shand, 2008).

The role is complicated, involving the direction and coordination of multiple multi-million dollar aircraft possessing considerable destructive capability in complex battle scenarios. It is also varied, being performed from numerous platforms and in diverse combat environments by a wide variety of personnel. It is therefore important to achieve very high levels of proficiency while being sensitive to the cost and safety concerns of training. Although one training analysis method may seem particularly useful, it is worth considering if others provide greater benefits and fewer costs.

In the sections that follow, we compare analyses of the JTAC role by both the CFITES and MEC methods. We focus particularly on the aspects of training analysis, and the design of training experiences, since these are the two most directly comparable elements between the two methods. We draw attention to where the two methods differ in terms of inputs or outcomes, consider possible uses, and examine possible compatibility between the two systems. Finally we offer a summary of our findings.

5 CFITES Applied to JTAC Training

5.1 CFITES Analysis in JTAC Training

The CAF has at least three current separate QS documents for the JTAC/TACP/FAC role since 2008. There one common Army QS for either non-commissioned member (NCM) or Officer occupation for a FAC (National Defence, 2012a), and two RCAF-generated QS documents for TACP, each respectively addressing NCM (operator) (National Defence, 2012c) and Officer (Forward Air Controller) occupations (National Defence, 2012b). For the JTAC role specifically, all service environments train to the Army QS and TP. The current versions of the RCAF QS documents were written four years after the convening of the original boards in 2008 following several years of deployments to Afghanistan and greater operational experience. Lessons learned from the theatre were deliberately included in the second writing, and the original QS was used as the template for the new version (National Defence, 2012b, 2012c). At the time of writing there were no superseding QS documents.

5.2 Inputs to the Process

5.2.1 Method and Materials

In each instance, a writing board was convened for a period of four days (National Defence, 2012a, 2012b, 2012c). They reviewed existing documents and procedures to examine gaps that could be modified by training, and then developed appropriate QSs with respective POs. Following the initial board meetings, work continued for development of the materials into their final form. The personnel and time expenditures for the additional development are not available.

Likewise TPs, instructional materials, and evaluation forms were developed for JTAC training, but details on their development were not available at the time of this writing. As an example from a different discipline, a TP development writing board for a Flight Instructor course had seven members who worked on the development over four days, with the board chair developing the work for an estimated additional 15 hours and the TDO providing an additional 40 hours of work (D. Mann, personal communication, October, 01 2015). This corresponds roughly with anecdotal reports from other writing board participants.

Several publications and manuals were referenced by each QS, some in common for both the Army and RCAF standards. The NATO STANAG was also referenced in the Army JTAC QS. Aside from these materials, the direct input of the board members provided the content for the writing board.

5.2.2 Personnel

In each instance of QS development, between eight and twelve participants served on the writing board, including the board chair and recorder. Personnel included officers and non-commissioned member SMEs from a range of operational and training organizations across the CAF. For the Army QS, the twelve members included members of the Air Land Integration Cell (National Defence, 2012a), while in the instance of the RCAF FAC QS, the nine members included fighter

pilots who also provided guidance as SMEs (National Defence, 2012b, 2012c). TDOs were included on every writing board. Importantly for the development of educational programs, TDOs provide advice in areas such as Evaluation, development of QS and TPs, co-ordination of instructor development, coaching and mentoring instructors, IT&E assessments, analysis of IT&E training problems, directing training development projects, promoting and implementing new instructional methods and technologies and being the Point of Contact for IT&E recommendations (National Defence, 2003c). The board members were identical for the both the RCAF controller and operator roles, and three members of the version one boards participated in the version two boards. This would encourage continuity and consistency on one hand; however it would also limit the breadth of input on the other.

Several publications and manuals were referenced by each QS, some in common for both the Army and RCAF standards. The North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) was also referenced in the Army JTAC QS.

5.3 Outputs of the Process

The complete CFITES process generates outputs throughout its application, but for this study, we are only considering the QS and TP. Although the Army JTAC documents are the principle items under consideration, additional perspective can be gained by comparing them briefly with the RCAF TACP outputs. The Army and RCAF QS documents differ somewhat, with POs that are different in content and structure. In terms of content, the documents describe differing but related roles, with the RCAF TACP qualification building on the JTAC. In terms of structure, the POs in the Army QS take the form of a one line title, the conditions for performance of the task, denied status, environment and standards of performance. The POs in the RCAF QS also has these items for each PO (although each in a different format in accordance with the preference of the specific training authority). One important difference aside from unique POs is that the Army JTAC QS also includes a task list as well as the specific level of proficiency required after training, which is absent for the RCAF QS. The structural differences of the documents are a result of the preferences of each Functional Authority (Army, RCN, RCAF). Ultimately the PO in each case contains the same basic information in that it has a Performance statement (paragraph 1), Conditions (paragraph 2) and Standards (paragraph 3), which describe all of the included tasks to be performed under the umbrella statement of the Performance Objective title.

The CAF QS for the JTAC role in this particular instance produced 4 POs, 23 EOs, 95 knowledge objective items and 124 trainable task objective items. As an example, one of the POs produced was “Advise ground commander on air assets in support of ground scheme of manoeuvre”. Each PO is subdivided into dedicated EOs, considered the principle unit of learning (National Defence, 1998c). For the above PO, the EOs included such items as “Advise ground commander on integration of CAS with indirect fires” and “Advise ground commander on types of Terminal Attack Control”. These are selected from an overall task list for the role. A numerical list of knowledge items required for the PO are also included and can be cross tabulated with definitions elsewhere in the QS. CFITES identifies knowledge as information that is independent of any task, and can be demonstrated by recall of the information (National Defence, 1998c). Examples of CFITES knowledge items for JTACs include “Characteristics, capabilities and effects of air to ground weapons” and “Terrain and weather effects on CAS missions”. The level of proficiency needed to perform the role is also listed on a 5 point scale, as well as a designation of whether the item is to be trained or not.

TPs and evaluation documents have also been produced as part of CFITES for JTAC/TACP/FAC. The official JTAC TP is a comprehensive document reiterating and detailing POs and EOs from the QS. The EOs "describe the conditions, standards, teaching points, references, resources required, and methods of instruction under which the POs will be trained." (National Defence, 2015b, pp. 2–2/6). In this way the TP describes what is to be trained and how to train it: this is called the *lesson specification.* The *lesson plan* however is created outside of the TP as part of the development process and includes the elements of introduction, body and conclusion as part of a structured and effective learning experience (National Defence, 1998d). Additionally, the TP describes policy regarding use of the document, course conduct, candidate management, grading, review, and lines of responsibility. Importantly, the TP includes an extensive set of appendices and annexes which include tools and instruments for assessment, check lists, course timetables, activity charts, supply and resource lists, and staff allocation charts (National Defence, 2015b). In doing so the TP adheres to CFITES doctrine.

In some instances ad hoc TPs may be developed for specific training or operational scenarios. Even these documents are subject to CFITES specifications, although they may at times fail to comply. One JTAC TP that was an annex to a larger campaign plan enumerated four "Training aims". Three of the aims had direct correlation with several knowledge items from the existing QS (National Defence, 2012a), although no specific mention of guidance from the QS or the principle TP was indicated. A fourth training aim was identified, but not a specific PO from the QS: using UHF radio in a LAV. This particular objective would appear to be very useful as it points to a gap, addressable by training, and should be considered for future revisions to the QS document. No actual training activities, lesson specifications, learning environments or success criteria were detailed in the above TP. Aside from the procedural breach, these improvised plans thwart careful advancement of teaching strategy since their content does not correspond with stated POs or EOs for the role. Consistent conformity could lead to greater course improvement. On the other hand, such lessons plans may demonstrate a need for agility to respond to training gaps that are perceived during operations, and it may be useful to provide suitable tools and structure to capitalize on such "just-in-time" training.

As mentioned earlier, CFITES stipulates that each training authority is responsible for Validation of training and education programmes. For the RCAF, Standards Evaluation Teams are responsible to develop and maintain operational standards and conduct audits of the training, currency and competence of personnel. The reports from these audits, detailing key findings and recommendations are forwarded to the wing command (National Defence, 2015a), and represent the principle validation of training within the RCAF. Although the revision of the Air Force TACP QS was responsive to operational experience, no reference to Evaluation or Validation of Instructional programs in the form of course and instructor evaluations, questionnaires, surveys, or after action reports was mentioned in the QS documents. A broader, and more systematic analysis as stipulated in the CFITES documents, particularly with respect to course delivery and student success (National Defence, 1998f, 2003b) and was not mentioned in the 2012 QS documents. Such analysis would typically address not only tactical concerns, but also issues related to course content and delivery.

5.4 Summary

The JTAC QS for the Army applies to all service environments, and is supported by a comprehensive TP document stipulating the details for conducting training. Developments in theatre have been incorporated into recent QS documents, as has the experience and knowledge of appropriate SMEs and TDOs. Systematic evaluation of the JTAC training system by the Standards Evaluation Teams, as called for by CFITES, were not examined in this study. While TPs are typically useful and practical tools for the delivery and evaluation of training, some may not consistently reference requirements of the QS, nor consistently employ evaluation methods directly addressing POs. A higher degree of specificity could improve feedback on learning for students, and greater operational preparedness.

6 MEC Applied To JTAC Training

6.1 The MEC Method in JTAC Training

The Mission Essential Competency process has recently been applied to the JTAC role to meet or supersede STANAG 3797: Minimum qualifications for forward air controllers and laser operators in support of forward air controllers (North Atlantic Treaty Organization, 2014) and the Joint Close Air Support (JCAS) Action Plan Memorandum of Agreement 2004-01 Joint Terminal Attack Controller (JTAC) (Ground) (Joint Fire Support Executive Steering Committee, 2013). Australia, Canada, New Zealand, the United Kingdom, and the United States of America collaborated on the analysis under the Joint and Coalition Training, Rehearsal and Exercise Research project arrangement under the Technical Cooperation Program (The Technical Cooperation Program, 2013). This collaboration, in addition to developing a set of Mission Essential Competencies for the JTAC role, provided the non-US collaborators with deeper insight into the MEC process as applied to a specific instance. The full process and results are described in Coalition Joint Terminal Attack Controller (JTAC) Mission Essential Competencies (SM): Final Summary Report (2015b). The inputs to the process and the outputs are summarized here based on the report Coalition Joint Terminal Attack Controller (JTAC) Mission Essential Competencies (SM): MEC Development Command Workshop (The Group for Organizational Effectiveness, 2015c) and observations by authors of this report.

6.2 Inputs to the Process

6.2.1 Method

The USAFRL contracted The Group for Organizational Effectiveness Incorporated to conduct the analysis, which closely followed written descriptions of the MEC process (Alliger et al., 2007). In January 2015, the first and second workshops were conducted in New Zealand. JTAC SMEs from Australia, Canada, New Zealand, United Kingdom and the United States contributed their knowledge, guided by facilitators. The collected SMEs represented several operational environments, including Air Force, Army, Marines and Special Operations Forces. These workshops developed and then refined the MECs and described the training context. Subsequently, the contractors edited the MECs and developed a set of surveys based on the workshop results for the purpose of capturing the training experiences, outcomes, and insights of the wider JTAC populations. The surveys were then administered by the contractors and local support personnel to both non-expert and expert JTACs in each country in the spring and summer of 2015. The survey results were then analyzed by the contractors. In August of 2015, nine JTAC SMEs, some of whom were also present at the first two workshops in New Zealand, reconvened for a third workshop in Dayton, Ohio to review and interpret the results of the surveys.

6.2.2 Personnel

The initial meeting of two workshops included ten JTAC SMEs, two professional MEC facilitators provided by the contractor, two USAFRL scientists, two USAFRL support team members and scientists from UK (one) and NZ (one) who provided country specific analytical

support. Twenty-eight hours were scheduled for the first workshop, and between-workshop-analysis took 16 hours over two days by the five US representatives: typically fewer facilitators accomplish this stage in less time (L. Rowe, personal communication, August 10, 2016) An additional 28 hours were scheduled for the second workshop (Defence Technology Agency, 2015). Normally, workshops are scheduled over three days and could be completed in as little as two, however extra time was granted to encourage discussion among participating nations (L. Rowe, personal communication, August 10, 2016). Surveys were developed by members of the analysis team, and five months after the initial workshops they were administered to 324 personnel across 17 locations in the coalition countries by the contractor with support from local personnel (One of the authors reviewed the questions, administered the questionnaire to Canadian JTACs and did simple data analysis on that data). The expert level surveys are more detailed and require 2.5–3 hours to complete, and the non-expert surveys take about 1.5 hours to complete. Expert JTACs had a mean of 7 years' experience, while the non-experts had a mean of 2 years' experience. The final Comprehensive Mission Needs Analysis and Determination (COMMAND) workshop, held after completion of the surveys required 17 hours of development time for nine SMEs. A minimum estimate for the total time spent—not including personnel required to administer the surveys, nor the extra hours required for offline analysis—is 2240 person-hours.

6.3 Outputs of the Process

The MEC process generates three principal types of output: descriptions of the characteristics to be effective in the role, the experiences needed to develop the characteristics, and the proficiency levels of the target population.

The description of characteristics necessary for the role in this particular instance identified 7 MECs, 21 SCs, 65 knowledge items, and 115 skill items. To provide an example, one of the MECs produced is "Advise/Update the Ground Commander". This competency begins before deployment and ends at the end of deployment. Many clusters of operationally relevant behaviour must be employed to successfully demonstrate this MEC. The SCs are high-level collections of skills or attributes, also demonstrated in operational environments, which are necessary to achieve the MECs. Some SCs relate to all MECs, and some to a particular MEC. In the case of the JTAC role, "Prioritizing", "Geospatial Awareness" and "Situational Awareness" were among the items identified as SCs. Knowledge is defined as information or facts that can be quickly accessed, and skills are defined as "compiled actions", although in each case the capacity must be demonstrable *under stress*. Examples of knowledge items for JTACs include "Contested Comms Procedures" and "CAS Request Formats and Procedures", while skill items include such things as "Operate Radios" and "Manage Airspace". These knowledge and skill items were ranked with respect to the level of proficiency needed to perform the role (Basic, Intermediate, Advanced, or Not Applicable), and mapped to experiences which can be expected to develop the skills, SCs and MECs.

Experiences required to develop the MECs, SCs, knowledge and skills are enumerated, and accompanied by statements about the educational purpose of each experience. This second output also includes described environments identified by SMEs as being capable of providing the required experiences, namely: school, continuation training, small unit exercises, combined arms / joint exercises / coalition exercises, accredited simulators, non-accredited simulators, and

combat operations. In some instances, for example “Operate in an Arctic Environment” or “Operating under effective Enemy Fire” the limitations of simulation or other training was recognized by the SMEs.

The last type of output described the current state of JTAC training. It included self-reports of absolute and relative mastery of the JTAC knowledge and skills, whether or not a given developmental experience is currently provided, whether there is a gap or potential gap with respect to training, and the level of priority for training the given item. In the case of this coalition effort, the gaps were delineated by country. Additionally, collective or country-specific commentary with respect to potential training environments, current training practices and possible limiting factors was included.

6.4 Observations of Application of the MEC Process

One of the authors observed all three workshops, with the others observing only the last. The authors made observations about the MEC process as applied in practice, which may be relevant for future application. These included observations about the structured process of the MEC process in general as well as about specific dynamics of the meeting of coalition SMEs.

The development and deployment of the questionnaire and analysis of its results are worth considering, as JTAC discussion during the COMMAND workshop at times touched on these issues, indicating differing opinions, attitudes, and definitions between the workshop SMEs and the surveyed population.

It appeared the questionnaire could be improved to ensure items were simply and unambiguously worded, possibly by having a sample of the population from outside the process pilot the product before distribution (Murray, 1999). Although survey delivery was proctored to address any questions by the respondents, at times the SMEs in the COMMAND workshop were surprised by the results, and guessed that those being surveyed must have misunderstood the question. In one instance, two SMEs had an offline discussion about the self-rating system employed in the questionnaires. They concluded that some of the responses gathered must have been based on a lack of clarity about the meanings of the levels, reasoning that if most JTACs did not meet the required standard it would be impossible for them to perform their jobs. Of course it is equally possible that the question was not clearly worded. Still for the most part, SME opinion did not differ from the questionnaire results.

In a few instances the SMEs did not agree with the answers of the respondents and in a few others they made assumptions about what the respondents actually meant. Additionally, in a few instances, there were discrepancies in the data, with mean and median values varying too greatly from each other to be mathematically possible. This was likely, as pointed out by the facilitator, the result of a mistyped spreadsheet formula. This problem was fixed immediately after it was discovered.

Regardless of these deviations, the SMEs would make recommendations, at times based on the aggregate results and at times independent of them. In one example, questionnaire results revealed that survey respondents did not consider ‘green-on-blue’ engagements[2] to be an

[2] Green-on-blue engagements occur when members of local armies or law-enforcement, thought to be sympathetic to coalition forces, attack members of the coalition.

important developmental experience. Initially some of the workshop participants agreed with the results, but others did not. During considerable discussion about the meaning of this experience, the SMEs developed consensus and reframed the idea realizing their initial categorization may have been mistaken. In this case the SMEs came to see as important a developmental experience they had initially downplayed.

The participants were deeply invested in the workshop process and expressed concern that their work there would not translate into any meaningful change at the level of policy or training. This concern may have reflected what Stanley and others define as *cynicism* due to observing previous failed attempts at institutional change, the belief that change is possible but unlikely, or a lack of confidence in change leaders, as opposed to *skepticism*, which reflects an overall doubt about the viability of change (Stanley, Meyer, & Topolnytsky, 2005). On the third day of the third workshop, the SMEs overtly began trying to predict how their input would influence future organizational decisions, and modified their responses to influence decision making. This departed from the direct advice that the workshop leaders appeared to be soliciting. Although the SMEs were trying to game the system, the intention was to improve training.

There was a particular limitation with respect to the scope of expertise of the SMEs. While highly expert in their combat role, and in some cases, even trainers in their countries of origin, these JTACs are not simulation or educational experts. They judged the capacity for training experiences based on their knowledge of current Live, Virtual and Constructive (LVC)[3] configurations. This may be problematic considering that the SMEs may not be aware of simulation environments that are state of the art, or on the near horizon. SMEs are largely dependent on their personal training experiences. Further without specific expertise in education or training, experts are not always in a position to recommend the most valuable training experiences or environments, particularly for novice learners (Hinds, Patterson, & Pfeffer, 2001). Nevertheless, training programs are developed outside of the MEC process by personnel with the required expertise, so the included commentary and recommendations about training environments are not the final word.

The JTACs shared and learned from their collective experiences. The pooling of experiences across the coalition provided a knowledge base that would be difficult for any one nation or service to obtain. For example, the impact of JTAC operations in amphibious, jungle, arctic, and desert environments were discussed.

6.5 Summary

The MEC process is highly structured: simple in concept, but manpower intensive to conduct properly. The structure provides a clear and direct path for execution of the gap analysis, with constraints and timelines for completion of the various steps, known costs, and standardized

[3] Live, Virtual and Constructive is a framework to classify modeling and simulation environments. 'Live' describes real world people on real world platforms (e.g., a pilot flying a real jet through the sky). 'Virtual' describes real world people performing tasks using some type of simulator in a synthetic environment (e.g., a real frigate crew on a real frigate at dock, but with sensor and video feeds simulating an operational environment). 'Constructive' describes computer generated entities (e.g., red-force aircraft and combatants). These three can be used together, with live participants engaging constructive enemies, assisted by team-mates in a virtual environment.

output products. It provides a clear auditable trail from government policy, through the approved essential task lists to training. While these features provide predictability and efficiency, they may also restrict the ability to modify the process to incorporate changes or ideas about the MEC process which emerge during the workshops. The process is resource intensive. The input of SMEs is used throughout the process, which increases the likelihood of relevance, while input is also invited from the operational community, which may improve validity as well as buy-in from those in the role. The focus on only SME insight may, however, also reduce the breadth of knowledge used in the creation of relevant developmental experiences. Equally, the SMEs may have biases with respect to training, as well as imperfect understanding of best training practices and incomplete knowledge of training media. Nevertheless, the act of collaboratively discussing the MECs among coalition partners generated a unique expertise and basis of understanding the requirements of the role.

7 Relating the Methods

The CFITES and MEC processes emerge from common ancestors in instructional design, yet have distinct methodologies based on their philosophical underpinnings, and in some ways are not truly comparable. CFITES uses a performance-based approach that generates task statements from the relevant community of practice, focuses on the thing to be done, and is founded in Behaviourist psychology and educational theory. By contrast, the MEC is based on standardized tasks which are used to generate competencies. The MEC focuses on preparing the person to do tasks, taking the perspective of Industrial/Organizational psychology.

Further, CFITES represents a comprehensive doctrine and system, while MEC is a discrete method for solving a specific problem. Despite these important differences, the processes share some elements in common. At the risk of gross over-simplification, the MEC process might be viewed as a subset of some CFITES elements: it focuses on the identification and analysis of a needs gap that can be addressed by training, and the subsequent characterization of experiences that are expected to nurture the requisite knowledge, skills, and SCs to close the gap. Seen through the lens of the ADDIE approach, MEC focuses on Analysis and part of the Design elements, while CFITES incorporates all of Analysis, Design, Development, Implementation and Evaluation, additionally including a Validation phase, amongst other features.

The CFITES analysis process is a fully integrated part of a broader Canadian Forces Human Resources management system. The CFITES Needs Assessment process determines if training is a suitable solution, and should that be the case, generates the necessary information to continue the full CFITES system. The main difference between the two processes is that the MEC is a stand-alone process to provide decision makers with information. In the discussion below, a principle comparison between CFITES and MEC analysis methods will be offered, followed by a brief consideration of additional features of the CFITES system.

There has been no direct experimental comparison between the CFITES and MEC approaches. In the absence of a scientific comparison of the performance of the two systems, below we offer a contrast of specific elements of each approach, considering first the requirements or inputs to each of the methods, the outputs, and additional items that merit consideration.

7.1 Process Inputs

CFITES is initiated within the context of CAF oversight and strategic guidance by specific process inputs. The initial inputs may be driven by changes in requirements of the DND, legislation, operational doctrine, organizational structure, equipment, as well as after action and accident reports, studies and inquiries. In some instances, an existing QS document will provide the basis for a re-examination of training needs. Documents such as Unit Qualification lists, Annual Military Occupational Reviews, Special Personnel Qualification Requirement and Post Graduate Qualification Requirements are used to support the motivational inputs (National Defence, 1998b). Full implementation at each phase of the CFITES method generates output necessary for the successful execution of subsequent phases, and input recursively informs future generations of an analysis applied to a given performance gap (Figure 5) (National Defence, 1998a).

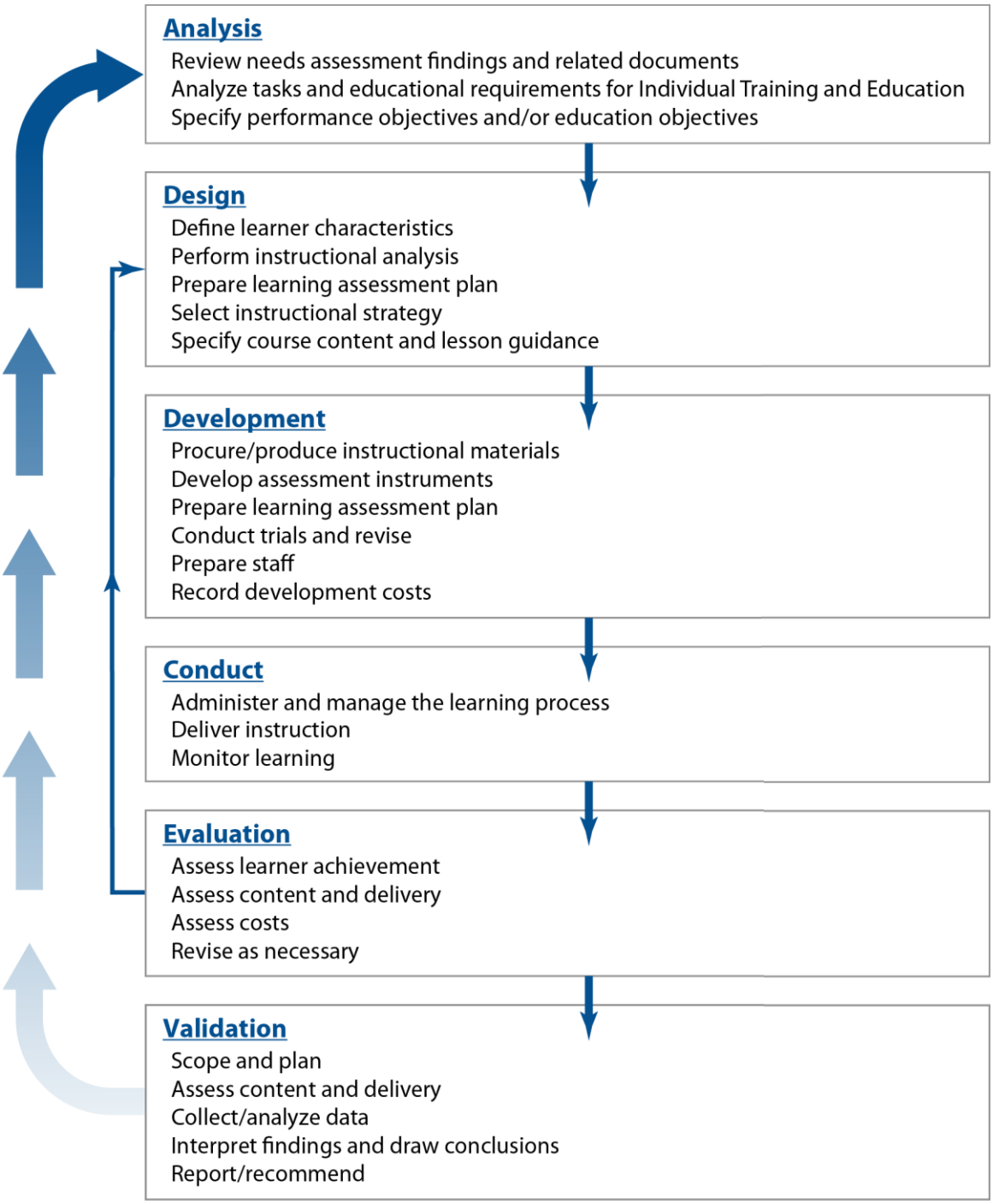

Figure 5: *CFITES control process summary, adapted from CFITES Volume 1.*

In a parallel fashion, the MEC inputs are generated in the context of USAF strategic guidance which stipulates that training must "cultivate Airmen trained in agile and robust decision-making to devise multi-domain solutions to complex problems in uncertain, contested environments." (United States Air Force, 2015, p. 57) MECs are related in concept to the USAF Universal Task

List (AFUTL), a doctrine-driven, high-level description of tasks that will support USAF missions. The AFUTL is served and given structure by Mission Essential Task List (METL), tasks essential to mission completion for organizations within the USAF. Additionally, very low-level, finely granular skills, such turning on a laser sighting device or finding a radio frequency are included in the Training Task List (TTL) and provide input for system and subsystem training activities but are not considered to fall within the MEC domain (Bennett et al., 2013).

7.1.1 Personnel

The consultation process during the Analysis phase of CFITES elicits input from stakeholders to the training, including Group/Command staff, employers, TDOs, SMEs, and educational specialists (National Defence, 1998f). For the existing FAC QS documents, the SMEs included experienced Forward Air Controllers, and fighter pilots in the case of the Air Force document, however no pilots were included in the development of the JTAC QS. Importantly, the inclusion of Training Development Officers may provide a distinct advantage in terms of understanding pedagogical principles, or perhaps the significance of a developmental stage.

The MEC process centers on the SME. The operational customer identifies the SMEs used in the three workshops of the analysis, assuring relevance and buy-in from the customer. Additionally the broader operational community, including both expert and non-expert operators provides input to the process through questionnaires. Workshop SMEs for the development of the coalition JTAC MEC included personnel from Air Force, Special Operations, Army, and Marine environment. Workshops and survey administration is performed by professional facilitators, and the analysis of workshop and survey data is conducted by contractors as well (Alliger et al., 2007).

7.1.2 Activities of Personnel

The CFITES analysis is performed by the above-listed personnel within a “Writing Board” group format over a series of meetings taking a number of working weeks to complete. The duration depends on the experience of the SMEs, the level of task complexity within the role, the number of tasks and the number of potential POs. The personnel perform the gap analysis and develop the requirements for the QS documents through face-to-face discussion at meetings.

Customer-identified SMEs in the MEC process generate the initial content through structured four-day workshops, then an additional four-day workshop to develop draft questionnaires, and later provide additional feedback on the questionnaire results. Through answering the questionnaires, expert and non-expert members of the broader operational communities provide information about their own operational and training experience within the role. These groups participate in distinct, time-bound activities to generate and collect the information relating to the competencies: four-day workshops for the SMEs, and answering of lengthy questionnaires for the broader community. Including all analyses, which occur “off-line”, the process can take more than a year from start to finish. Workshops and survey administration is performed by professional facilitators, and the analysis of workshop and survey data is conducted by contractors as well (Alliger et al., 2007).

7.1.3 Ecological Verification

The ecological validity of CFITES programs of instruction is verified during the Validation of Instructional Programs and Evaluation of Instructional Programs phases of the method: after courses have been developed and employed there is feedback from instructors, students and the operational community about the effectiveness of the course. The inputs for these analyses are course results, After Action Reports, Lessons Learned reports, course evaluations, questionnaires, satisfaction surveys, focus groups, performance checks and other inputs (National Defence, 1998f, 2003b). This feedback is then incorporated into future versions of the QS document. QS revision is mandated to occur every three to five years, but revised as required. Overall, the input of other members of the operational community may not be implemented until months or even years after the initial writing.

By contrast the ecological validity of the MEC system is achieved by the iterative nature of the process at the analysis level. The initial material is developed by the SMEs, informed and influenced by the opinions and experiences of the broader operational community, then further commented upon and subsequently changed by means of the last workshop group. The facilitators of the process are catalysts to the thinking, asking naïve questions, provoking discussion around contentious issues and pushing the ideas over roadblocks and impasses.

The CFITES analysis depends entirely on the professional expertise of the gathered working group of SMEs and members of the training establishment, notably a TDO who acts as an arbiter, and provides expertise on relevant pedagogical issues. The MEC process, on the other hand, uses SMEs, expert and non-expert opinion from the operational community, and scrutable surveying and analytic techniques. In either case the SMEs verify the tasks identified in the specifications being developed against their personal body of knowledge and deployment experience deliberately solicited to improve the relevance of the training. Quite often, tasks are either added because they are missing, or deleted as they are irrelevant.

An important point is that in practice both methods appear to weigh the collected and distilled opinions of the SMEs as equivalent to fact. In the case of CFITES, the Validation and Evaluation processes make use of expert opinion and in some instances collected data from users with respect to the efficacy of the program in question (National Defence, 1998f, 2003b), and as the document *Leadership in the Canadian Forces: Leading the Institution* points out, the process of developing educational materials "is grounded in theory; it is rational and largely empirically verifiable. Broadly speaking, it is scientific." (National Defence, 2007, p. 7) Of course, the iterative process of amending a curriculum based on the opinions of many members of the community, are vital methods providing actionable information. However, these processes should not be confused with information about proficiency and training effectiveness which has been derived through experimentation or direct observation and statistical analysis. Collecting data on proficiency and training effectiveness is addressed only generally in CFITES and is outside the scope of the MEC process.

For instance, the SMEs in the third workshop would at times, based on their own experience and knowledge, refute suggestions from the first two workshops or critique survey results. In some instances the very same SMEs who had proposed the idea would later argue against it. This is not an issue of bias, but of reconsidering an idea when reframed or after a passage of time. For example, one possible Key Experience in the JTAC MEC process was "Work with live tissue".

Working with live tissue, for example living pigs with induced trauma, is thought to be useful for medical personnel and others who may come in contact with injured soldiers (Savage et al., 2015). This experience was considered important enough for the SMEs in the first two workshops to advance it after some debate, ostensibly because JTACs might call for a medical evacuation. During the third workshop, however, based on the surveys and their opinions, the gathered SMEs, identified the training experience as irrelevant to JTAC training per se, but rather pertaining to combat training in general. JTAC SMEs performing the same process in CFITES might very well have reached a similar conclusion (or never considered it in the first place). Of course, it is reasonable to assume that working with live tissue may not be a critical experience for JTACs. Further it is also reasonable to assume that the iterative process of idea generation and review by peers should develop more meaningful or relevant information.

Still, this must not be confused for scientific evidence or fact. No study was performed comparing the eventual combat performance of JTACs who had or had not received training with live tissue, yet it is certainly within the realm of possibility that working with live tissue *could* improve JTAC performance on a number of measures, regardless of the opinions of the SMEs.[4] This same argument holds for every item produced in the MEC analysis, including training experiences that SMEs feel *must* be included, but which have not been experimentally proven to provide meaningful benefit. The process is not rigorously scientific for either analysis method, although the MEC does provide a meaningful step forward from other methods, with a more widely distributed analysis of opinion across many participants filling a given role, and a comparison of expert and non-expert opinion which allows for a weighting of the two sets of input.

7.2 Comparison of Process Outputs

The CFITES process produces a large number of outputs. Some outputs are specifically tied to the Analysis phase of the method and include training and non-training task lists, proposed instructional strategies, POs, and the QSs (National Defence, 2003a). The training list is analyzed further as part of the Analysis of Instructional Requirements phase of CFITES (the non-training list is returned to the sponsor for further consideration). The Analysis of Instructional Requirements generates a set of learning outcomes expressing measures of how the task it to be done, and to what proficiency. These contextualized outcomes are compiled in a PO, a structured formal statement of what the candidate must be able to do in completion of an identified task or set of related tasks. It identifies the relevant supporting knowledge elements, and may identify indicator attitudes or guiding behaviours. An example of such behaviours is workplace safety—wearing appropriate equipment to prevent or reduce injury while performing tasks that have a potential for personal injury. All POs are collected and sequenced in a QS, a formal, legal document which directs the implementation of training and provides a benchmark for the performance of students, courses and the success of the training program as a whole (National Defence, 1998b, 2003a). These items are most directly comparable to outputs from the MEC method. In addition to the full competency statements, the MEC process generates one list each of the Knowledge, Skills and SCs necessary to realize the MECs. Another MEC output distills recommendations gathered from the SMEs to express a set of Supporting and Developmental Experiences needed to evoke the

[4] The "Work with Live Tissue" developmental experience was included in the final report, with the stated purpose "Provides realism in dealing with casualties in self or others; desensitizes to battlefield trauma". It is accompanied by the comment "This is not a gap and not a relevant requirement or experience for a JTAC."

required learning. These various outputs are collected in complex relational spreadsheets that can present the information in a number of ways. These tools can be used by trainers to create meaningful and efficient training experiences that can capitalize on a mix of LVC training environments, depending on budget and opportunity (Bennett et al., 2013).

7.2.1 Success Criteria

Both CFITES and MEC processes select outcomes to be trained or not trained based on a set of criteria established by each SME group. Again for identification of training items, CFITES relies exclusively on the expertise of the SME working group, but the MEC process includes the input of the broader community to select and prioritize these criteria. Criteria for success developed by the SMEs of CFITES are expressed in the form of *knowledge, skills and attitudes* compiled in *task lists* while the criteria developed by the participants within the MEC process are written in the form of *knowledge*, *skills, Supporting Competencies* and *developmental experiences*. The conditions under which the task or competency should be performed are specified in both methods, as are the requisite levels of proficiency. CFITES defines the job performance as it is to be undertaken in any of the conditions described but the MEC process is concerned specifically with performance on a given Mission.

7.2.2 Outputs of Other CFITES Phases

Additional CFITES outputs are reflective of the application of a specific phase of the system. The design phase results in a Training Education Plan, which itself includes a list of enabling objectives, plans and potential instruments for assessment of learning, a list of possible instructional methods and media, and a business case for the selected instructional solution(s) (National Defence, 1998c). The Development phase results in production of instructional materials, including print, audio visual and technology based materials, the creation of assessment instruments, course timetables and lesson plans. It further results in training for instructional and support staff. All materials at this stage are also translated into English or French (National Defence, 1998d). The Validation phase generates evidence about the effectiveness and efficiency of the training in the form of responses to questionnaires, interviews, observation and test results all of which are compiled, analyzed and interpreted in the form of a report (National Defence, 1998f). A similar process is applied in the Evaluation phase, in which the benefit of the program of instruction is assessed. An evaluation checklist is created, and an instrument such as Kirkpatrick's Evaluation Model is used to gather data from instructors and students, along with trend analyses, course evaluation forms, cost assessments and other information which is explored and summarized in a formal report which includes the input of key stakeholders (National Defence, 2003b). By contrast, the MEC process is concluded when the reports are delivered. Training programs are developed, delivered and evaluated independently of the MEC development.

7.3 A Comparison of CFITES and MEC Products Against Gaps in the RCAF Simulation Strategy

While very focused and speculative, future requirements may provide a specific opportunity to assess some of the differences between the two systems. The Directorate of Air Simulation and

Training (DAST) has developed a strategic roadmap for the implementation of a 'simulation first' training strategy. The objective of the strategy is to apply LVC training experiences in a shared synthetic environment in order to reduce cost and risk associated with live training, and to improve training variability, distributed access, and opportunities for collective training. The target date for full implementation is 2025, and DAST has identified ten critical elements for simulation-based training. Of those, four were identified as gap items with respect to enacting the strategy (Royal Canadian Air Force 2014a, 2014b).

Using key statements within the four client-identified gaps, one researcher (Martin, 2016) developed a series of Likert scale items to provide a structured analysis. The items were clustered into four categories: links between training and strategic guidance; simulation and media use; collective training; and tools for trainee assessment and training program evaluation. A fifth category regarding overall usability was also included to explore rater bias against the documents themselves. The rating items were presented to three raters with differing expertise in modeling and simulation, training, education, and the JTAC role. The raters were asked to apply the scale criteria to both the CFITES QS (National Defence, 2012a) and TP (National Defence, 2015b) documents for JTAC, and the coalition-developed MEC Summary Report (The Group for Organizational Effectiveness, 2015b) and Comprehensive Mission Needs Analysis and Determination (COMMAND) Worksheet (The Group for Organizational Effectiveness, 2015a). The outputs of both the CFITES and the MEC methodologies performed poorly in terms of addressing the gap items identified in the RCAF strategy document, particularly with respect to links with strategic guidance, appropriate media, use and nurturing of simulation-based training, or opportunities and direction for collective training. The CFITES documents were rated as providing better tools and instruments to assess trainee progress, and amending and improving the TP, while the MEC documents were rated as being more likely to contribute to operational readiness.

The analysis suggests that more explicit reference to strategic guidance and objectives (such as simulation-based training or collective training) from the outset of needs analysis might address the deficiencies in either system. However it is possible that CFITES might be more amenable to including such direction because the system is more prescriptive overall, while the MEC methodology is more consultative of the broader operational community whose culture and preferences might be at odds with strategy. A key example is the current use of simulation in each of the systems. In the current JTAC TP in the CAF, simulation was suggested in only four instances. A new media analysis for the TP which incorporates the objectives of the simulation strategy could easily augment the number and quality of simulation-based training experiences. By contrast, in the MEC analysis, in no instance did survey respondents consider simulation to be superior to combat or combined arms exercises for delivering a developmental experience: even with a mandate to include more simulation-based training, this preference would be unlikely to change. If media use is developed based on the Summary Report, it would be difficult to invoke the strategy until operators change their attitude toward simulation.

The author recognizes that the analysis was limited only to the gap items and as a result might not have captured aspects of performance of the two systems which possibly would address the other six critical items designated as critical to development of simulation-based training strategy.

7.4 Further Considerations

7.4.1 Assumptions with Respect to Performance Gap

The CFITES model assumes that there may be several possible means of closing an identified performance gap, one of which may be training, despite the fact that it may be the most costly solution (National Defence, 2003a). The Needs Assessment occurs prior to the Analysis of Instructional requirements to determine all possible solutions. If an analysis of training takes place, it is only after other options have been considered and eliminated as being less effective than training (National Defence, 1998b). By contrast, the MEC process begins with the criterion of successful performance of a given role in the combat environment (Alliger et al., 2007). The method is engaged with the assumption that training has already been determined to be the best means to close any gap between current and desired performance, however potential changes to organizations, equipment or rules that are generated by the SMEs are captured during the workshop experiences (L. Rowe, personal communication, August 10, 2016). In other words the MEC process does not include its own filtering system, but relies on external checks and balances to ensure it is being applied when necessary.

7.4.2 Flexibility

Because CFITES is one element within the broader context of a collection of Canadian Forces management systems, CFITES represents a systems approach to individual training. By that definition, it should be responsive to the influence of the other components of the management system (National Defence, 1998a; Watson, 1981). This allows the CFITES to be adaptable to other environments, for example where the focus is more directly on education rather than training (Scoppio, 2009), or as the system evolves, the anticipated inclusion of collective training. As mentioned above, two instances of collective training have already been developed under CFITES. Overall, the methods in the analysis as well as the outcomes are expected to be responsive to the size, structure and culture of the organization; any limits on time, funding and other resources; as well as sensitivity to any classified content (National Defence, 1998b). This expectation should allow the system to be more economical in some instances, since not all elements would need to be applied with equal scale. Once a TP is developed, however, there is a fairly rigid specification with respect to the activities and number of hours required to be spent in a given activity as specified by the plan. The above examples suggest that CFITES is flexible, but the degree to which this is actually the case would require addition investigation.

By contrast, the MEC process is more rigid during its execution. Still, the resultant product allows for considerable flexibility of application across facilities, opportunities and training media. The MEC process provides guidance as to what should be trained and how that may be done optimally, but it is up to the individual training organization to ensure that the Developmental Experiences covering the identified gaps in knowledge, skills, and SCs are sufficiently addressed.

Use of the MEC is also restricted in another sense, by the service mark and control of the results held by AFRL. Currently, full execution of the MEC process can only be performed by AFRL and its contractors, the Group for Organizational Effectiveness Incorporated and Aptima Incorporated. AFRL has provided permission and training for other organizations in partner nations to perform some aspects of the MEC analysis in the past and is willing to do so in the

future. For example, MECs is carried out in the UK via a Memorandum of Understanding between AFRL and the Defence Science and Technology Laboratory (DSTL) (Secretary of State for Defense of the United Kingdom of Great Britain and Northern Ireland, 2002): DSTL analysts have been fully trained in the process and an industry contractor has been trained and accredited to conduct MEC facilitation (H. Keirl, personal communication, October 29, 2016). AFRL also imposes restrictions on the distribution of MEC analyses, limiting them to defence departments and defence contractors who have signed non-disclosure agreements with the USAF. Since Canada owns the CFITES process, such restrictions do not exist in its use.

7.4.3 Structured Process

CFITES is a doctrine rather than a procedure: it provides a set of principles for accomplishment of its goals, but no explicit prescription or directive for specific methods. As a consequence, interpretation of the requirements as well as the rigor of each step will be determined by each user. Some elements may receive more or less attention or be practiced differently. For the same reasons, CFITES is not applied identically in all instances. The processes and products from one use of the system are likely to be difficult to apply to any situation that is not very closely alike. However some POs may be adapted from one use to another.

By contrast, the MEC process is a sequential progression from one process element to the next and is designed to be reliable and repeatable. Each step is discrete and clearly defined where specially trained facilitators guide the *process* while discipline-specific SMEs provide the *content*. Facilitation personnel will participate in many development activities, allowing them to refine their skills. Of course this has particular benefit to the contractors who are able to optimize time use, but also provides a clear and known product, since this staged process is owned and practiced by certified facilitators. This also provides planning benefits because the requirements for personnel, time and resources are predictable from iteration to iteration. Survey development, deployment and analysis remain constant between iterations and across disciplines.

Some of the products can even be applied to more than one platform. For example, when a new fast fighter jet variant is analyzed, some of the relevant competencies from the parent platform can be transplanted in what has been called a “starting deck” to the new analysis (G. Alliger, personal communication, June 11, 2015). Finally, although not an explicit goal of the process, consistent or standard types of measures with respect to performance have the benefit of facilitating comparison among measures and among iterations of the process.

7.4.4 Individual vs. Collective Training

In the JTAC training example, CFITES and MEC were applied to the training of individuals. Both systems provide analyses to determine what training is required to advance personnel from initial intake to operational readiness. In the case of CFITES, the task is the focal point of the analysis, while with MEC, the trainee in the mission is the focal point. However, there is no particular reason to restrict the application of either system and its respective analytical tools exclusively to the training of individuals, and both systems have been applied to the training of collectives (Bennett et al., 2013).

For CFITES, identification of collective tasks would produce performance objectives and enabling objectives that would require teams or groups of teams working in concert to accomplish. For MEC, the identification of a collective mission would generate Mission Essential Competencies, Supporting Competencies and Developmental Experiences to prepare teams or groups of teams to meet the mission in a non-permissive environment. In either instance what is required is a clear definition of the collective nature of the thing to be learned. Of course, purpose-made collective training needs analysis methods include tools and processes particular to the collective, considering such things as the interactions of the individual and group as influenced by member skills and personalities, group structure and cohesiveness, as well as performance outcomes at individual and group levels (Huddlestone & Pike, 2014; Pike & Huddlestone, 2011). At present neither CFITES nor MEC directly addresses these issues.

7.5 Summary

The two systems being examined here demonstrate some areas of overlap as they each express phases or extended phases of modified ADDIE processes. CFITES is a comprehensive method that includes the entire systems approach to training. It provides considerable flexibility during the analysis phase, but requires adherence to prescription during training delivery. By contrast MEC is formally structured during analysis and has greater flexibility during training delivery, and provides a resource for external execution of the complete systems approach to training.

The MEC method also provides for contextual relevance and adaptable developmental experiences that can be applied in accordance with opportunity. Neither system provides a distinct advantage with respect to a simulation-first training strategy or for collective training, although the more top-down approach of CFITES might advantage strategic guidance for prescriptively developing those ideas.

8 Compatibility of MEC with IT&E and CFITES

As approaches to addressing gaps in training, both the CFITES and the MEC method employ particular inputs and outputs, and operate on given assumptions. CFITES is a broader system including all features of an enhanced ADDIE approach, while the MEC method isolates analysis, design and some aspects of development. It is worth considering whether some or all elements of the MEC approach have utility and compatibility within the context of CFITES. The MEC process may offer possible benefits of a more formally structured process, repeatability and clarity of application, to a CFITES system that enjoys flexibility and scalability. Still, there are some challenges and specific areas of hindrance between the two systems.

8.1 Flexible vs. Prescribed Analysis

If one considers the points of congruency between CFITES and the MEC approach, they share aspects of Analysis, Design and part of the Development phases of ADDIE methodologies, although the *means* of accomplishing the phases differs considerably in each. The CFITES approach to the shared elements is variable in its application from instance to instance in accordance with the specific demands, resources and scale of the training being considered. The MEC approach is applied rigorously in each instance. In this respect, applying the MEC approach inflexibly in a small military could be prohibitively costly for roles with relatively few personnel, or where the cost of training is relatively low. This may mean determining a break-point for engaging a MEC-like process so that economies of scale might be appropriately exploited. It might also be possible for coalition nations to collectively develop MECs (as done with the present JTAC instance) so that costs and benefits are shared among participating nations, or alternatively for some manner of a streamlined MEC process to be applied.

8.2 Tasks vs. Competencies

CFITES is designed to be used in a task-oriented, performance-based environment. Tasks are viewed as "*meant to include any substantive aspect of performance that contributes to an operational or Departmental requirement"* (National Defence, 1998f, p. 3). By contrast, the Competency of the MEC is a strongly contextual higher 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 et al., 2007, p. 14) This difference can be illustrated by considering the concept of targeting as approached by each system.

In close air support, the detection, identification, and location of targets is critical. In the CFITES JTAC QS there are 4 of 95 knowledge items and 24 of 124 task items devoted to targeting, supporting four broad performance objectives: advising the ground commander about air asset capability, and planning, preparing, and executing tactical air operations. Each PO requires the candidate to possess all knowledge items, and the three later POs each also require performance of up to 18 separate task items involving targeting, including separate and distinct task items for targeting during the day or at night. The training and assessment of each task is specific and focal, and lessons and training experiences are structured to ensure the task can be performed as required. For the MEC JTAC analysis, one of the Mission Essential Competencies is "Acquire

Targets in the Operating Environment". In this case one particular skill, "Derive Target Location", could be developed through any one of 31 relevant developmental experiences. Although individual skills and knowledge required for a competency have expected levels of expertise, no single task proficiency is developed or demonstrated in isolation. Each developmental experience is also ranked by its capacity to develop each MEC to a greater or lesser extent.

'Tasks' ('skills' in the MEC approach) still exist and have importance within a competency model; however the emphasis is considerably different. To use MEC within the context of CFITES would require a paradigmatic shift in the way the role is conceived, trained and evaluated.

8.3 Job vs. Mission

The methods differ in scope and application as a result of the "job" focus of CFITES, and the "mission" focus of the MEC. Ultimately, the QS, task analysis and TP are structured to develop personnel for accomplishment of a specific job (National Defence, 2002), and the system is concerned with preparing personnel for all aspects of that job. Consequently CFITES addresses *all* tasks that are part of the role and responsibilities of a given job as they might apply to *any situation* whether operational or non-operational, while the MEC considers *only* tasks as they are used in a real, practice or simulated combat environment. MEC is concerned with the mission, a discrete, time and event-bound unit of occupational function in an operational context. In this way, the criteria for success are derived from performance in combat environments (Bennett et al., 2013). The rationale is that SMEs prefer requirements that are specific, concrete and contextualized (Bennett et al., 2013).

If a mission-based perspective is seen as advantageous, it may be possible to develop more operationally relevant criteria within the CFITES framework. Presently, there is work being done by Military Personnel Generation (MILPERSGEN) and Director General Military Personnel Research and Analysis (DGMPRA) to write the Officer General Specifications and the NCM General Specifications using competencies to describe the requirements replacing the descriptions in terms of tasks to be accomplished (B. Dececchi, personal communication, March 23, 2016). It is worth noting that there is no discernible whole force, mission-specific training authority in the CAF, however the RCAF guidance document on Interim Air Force Expeditionary Task Standards suggests that the Expeditionary Readiness Centre within 2 Wing will hold this responsibility. This interim standard puts forth both Mission Essential Tasks and Mission Essential Task List as part of its discussion on collective training concepts (Royal Canadian Air Force, 2013). Again, these are distinct from *competencies*, but are still promoting training in the context of mission completion. Even if such mission-focused thinking is applied to tasks and task lists, the Military Occupational Structure and subsequent Occupational Standards could be converted next from task-based requirements to competencies, which would allow for a cross-pollination of information from CFITES to MEC if required, including competencies SCs that are common to all roles in the CAF. To address the remainder of the job—that is, situations when members are not deployed—non-operational or maintenance competencies could be developed which could increase the benefit of those situations.

8.4 Individual vs. Collective Training

In Canadian Forces doctrine there are both individual and collective training systems. Collective training focuses on "cohesive, combat-capable tactical groupings" (National Defence, 2001, p. 9). At this point in time CFITES is employed principally for individual training and education, not for group instruction (National Defence, 1998a), although the system is currently being revised to clearly include a focus on collective training as well. The MEC differs in that the analysis is intended to address competency needs of the individual *within a team*, which in turn is found in the context of *teams of teams* (Bennett et al., 2013; Colegrove & Bennett, 2006). That is, there is an assumed interdependency of roles that requires specific training to address the demands of interacting with other team members who themselves require related training. Still, there is no particular reason why the tools of CFITES cannot be applied systematically to collective training. What would be required is a clear definition of the role or collective that illuminates its collective nature. This would provide the structure for developing a training framework that anticipates the need for interactions among members of the collective and how training would need to be shaped to accommodate those constructs. From that starting point, an integrated MEC-type analysis with appropriately adapted design, development, implementation, evaluation and validation phases could be engaged. The explicit collective focus of MEC during the analysis and early part of the design phases of CFITES could be beneficial for developing collective training strategies.

8.5 Management

The management of the MEC *process* constrains its compatibility with CFITES. AFRL's control of the quality of the MEC method by restricting who can perform the analysis and how it must be carried out imposes constraints on the development of training. CFITES is executed by all the CAF's Training Development Officers who can be supplemented by a variety of contractors, as required. To use both systems together, however, would require either a special contracting effort to obtain a MEC analysis, or a TDO's education would have to include certification in the MEC method.

The management of the MEC *products* also constrains its compatibility with CFITES. CFITES products are owned by the CAF and can be used as it sees fit. Incorporating MEC products into the CFITES products will limit how the training material can be shared, distributed, and provided to contractors. Furthermore, the need to obtain permission from the USAF to provide the MEC results to a contractor imposes a risk that has generally not been present in this type of training material in the past.

8.6 Performance Objectives vs. Developmental Experiences

The differentiation between a Performance Objective (PO) from the CFITES system and a developmental experience from the MEC system has important considerations for training. The CFITES development of specific POs and a definitive TP provides a clear and unified structure for overcoming any performance gap that can be resolved through training. Once the TP is developed, it can be applied, evaluated, and revised as it is delivered. However delivery of a specified TP may not be possible because of unavailability of equipment, training environment, or teaching personnel. In the MEC method, the distillation of Knowledge, Skills and SCs into

statements of the required performance in an operational context (MECs) is remarkably useful in grasping how developmental experiences can be structured to develop a combat-ready soldier. The MEC process does not explicitly state *how* training should be conducted or assessed. Still, by identifying all training environments that could potentially develop a skill, instructors have flexibility to structure training within the constraints of budget, time and facilities. The ability to adapt the training to the situation may also improve 'just-in-time' training where the delivery of developmental experiences may need to be improvised.

Clearly identifiable levels of performance are useful for students, instructors and leadership alike. They provide feedback on student progress (Salmoni, Schmidt, & Walter, 1984), efficiency of training and effectiveness of programs, as well as providing criteria for tenure and promotion and a benchmark for gauging training for maintenance or rehabilitation. The PO created through CFITES is intended to demonstrate both the accepted level of performance and indicate the level of proficiency achieved by the student (National Defence, 2003a).

8.7 Summary

There are fundamental differences between the CFITES and MEC approaches; however thoughtful adjustments to each could permit compatibility. The prescribed tools and processes of MEC might provide more streamlined outcome documents and could also benefit a collective training focus, but would require a re-thinking of job requirements in terms of competencies. Replacing the analysis phases of CFITES with MEC (Figure 6) would impact the other phases of CFITES as well. An important question is whether the prescribed application and management of the MEC approach could be adapted to the particular needs of the CAF, given the scale and diversity of training requirements within the CAF.

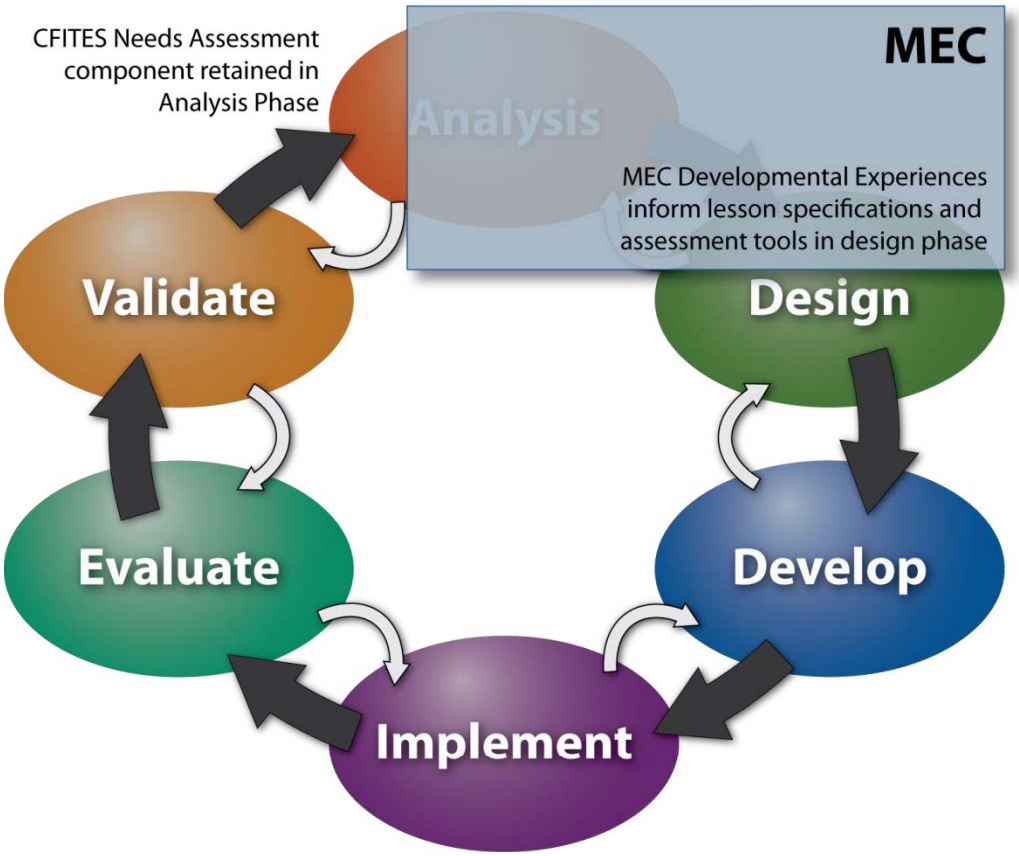

Figure 6: *A hypothetical integration of MEC into CFITES.*

9 Conclusions

The criticality of training to military operations demands that training be done well. The high potential costs of training demands that it be done efficiently. For both of these reasons, militaries are considering new training analysis methodologies for team and collective tasks. Part of this examination should involve the compatibility of their current methodologies with new options under consideration. The potential use of MECs by the RCAF presents such a situation. The prior application of CFITES to JTAC training and the recent coalition application of MECs to JTAC training presented the opportunity and substance for examining the relationship between the two methodologies.

The results of our examination revealed that CFITES addresses a greater breadth of the systems approach to training and that it provides considerable flexibility in techniques. MEC provides a rigorous and prescriptive method for analyzing training the competencies required to conduct operations in a non-permissive environment. It is apparent that the two methods do not do the same thing and are not interchangeable. They do appear to be compatible, however.

MEC could be incorporated into CFITES as one particular technique amongst the variety of techniques within CFITES. A decision to employ MEC within the CFITES process would require consideration of four points. First, MEC entails commitment of significant funding, time, and expertise, and should therefore be applied where warranted. Second, the number of SMEs required may outstrip those available in the CAF, necessitating either a collaborative effort with allies or accepting the risk of having SMEs that are too few in number or insufficiently experienced. Third, the MEC method is not sufficient, and additional effort will be required to produce all the products provided by CFITES, such as performance criteria. Finally, MEC is not comprehensive, again necessitating additional effort to address requirements that occur outside the mission as defined by MEC.

Finally, the analysis presented here is not definitive. In terms of the methodologies it examined, only two were dealt with in depth. Other collective training analysis approaches are worthy of consideration and may have associated inputs and outputs that are likewise appealing. Ultimately, the decision to adopt an analysis methodology will involve balancing risks. The time and funding necessary to apply and test new collective methodologies at a scale sufficient to support a statistical decision is prohibitive. Case studies applying and evaluating methodologies examining the costs, benefits, and risks of retaining current methods and of candidate methods appear to be the best way to inform the selection decision.

9.1 Recommendations

The relationship between MEC and the general competency analysis underway in the CAF should be considered. The examination should determine similarities between competencies identified through the MEC method and the competency dictionary being developed for the CAF (Ruscito & Rankin, 2013) and how contextually defined competencies like MEC can or cannot be accommodated into the general competency framework.

CFITES and MEC are two methods for approaching training requirements, and both have merits and are compatible. However, there are other methods for establishing collective training requirements (Huddlestone & Pike, 2014), and these should also be considered. As CFITES is being revised at the writing of this work, the most recent revision of CFITES should be included in any comparison of collective training methodologies. Depending on timing, such an examination would serve to evaluate an alternative or to influence the revision of CFITES.

This comparison was informed by the analysis of JTAC training. The JTAC role, although demanding, is not representative of RCAF aircrew training. Opportunities to participate in MEC analyses of roles directly relevant to aircrew training should be seized as they emerge.

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List of Symbols/Abbreviations/Acronyms/Initialisms

ADDIE	Analysis Design Develop Implement Evaluate
AFRL	Air Force Research Lab
AFTEMS	Air Force Training and Education Management System
AFUTL	Air Force Universal Task List
AWACS	Air Warning and Control System
CAF	Canadian Armed Forces
CAS	Close Air Support
CFITES	Canadian Forces Individual Training and Education System
CFPDS	Canadian Forces Professional Development System
COMMAND	Comprehensive Mission Needs Analysis and Determination
DAST	Directorate of Air Simulation and Training
DGMPRA	Director General Military Personnel Research and Analysis
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DSTL	Defence Science and Technology Laboratory
EO	Enabling Objective
FAC	Forward Air Controller
FIC	Flight Instructor Course
ID	Instructional Design
ISD	Instructional Systems Design or Instructional Systems Development
IT&E	Individual Training and Education
JTAC	Joint Terminal Attack Controller
LAV	Light Armored Vehicle
LVC	Live, Virtual And Constructive
MEC	Mission Essential Competency
MILPERSGEN	Military Personnel Generation
MOA	Memorandum of Agreement
NATO	North Atlantic Treaty Organization
NCM	Non-Commissioned Member
PO	Performance Objective

QS	Qualification Standard
R&D	Research & Development
RCAF	Royal Canadian Air Force
RCN	Royal Canadian Navy
SC	Supporting Competency
SET	Standards Evaluation Team
SME	Subject Matter Expert
STANAG	Standardization Agreement
TACP	Tactical Air Control Party
TCTNA	Team and Collective Training Needs Analysis
TDO	Training Development Officer
TP	Training Plan
TTL	Training Task List
TTP	Tactics, Techniques, Procedures
UHF	Ultra-High Frequency
USAFRL	United States Air Force Research Lab

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The distributed and interdependent nature of modern armed conflict requires militaries that can function in collective environments. Given the considerable cost of training it is important to train the right people to do the right job in the right way. In developing its strategy to use distributed simulation to provide aircrew with collective training, the Royal Canadian Air Force (RCAF) questioned whether its training analysis method could be improved not just for individuals but in the context of teams and teams of teams. Currently the RCAF uses the Canadian Forces Individual Training and Education System (CFITES) to determine and address gaps in training; however, other models of analysis might better perform this same function. Training needs for the Joint Terminal Attack Controller (JTAC) have previously been analyzed using CFITES, and more recently using a different method, the Mission Essential Competency (MEC), used by Canada's closest ally, the United States. These parallel analyses allowed an exploration of differences and points of intersection between the systems, as well as possible opportunities to exploit the strengths of each system. This paper examines the characteristics of the two methods and examines their application to JTAC training, noting process inputs and outputs, strengths and limitations. Our analysis suggested that CFITES addresses considerably more aspects of training with greater flexibility than MEC; however the MEC analysis process offers excellent output for structuring training, particularly with respect to operationally contextualized and collective performance. By adopting the MEC as a particular kind of analysis within the broader scope of CFITES it would be possible to derive significant benefits offered by the MEC method within the larger framework provided by CFITES.

Le fait que les conflits armés modernes peuvent être, de par leur nature, tant disséminés qu'interdépendants exige que les militaires puissent fonctionner dans des environnements où ils sont appelés à travailler collectivement. Étant donné le coût élevé de la formation, il est important d'instruire les bonnes personnes pour effectuer le bon travail de la bonne façon. Lorsqu'elle a élaboré sa stratégie d'utilisation de la simulation répartie pour dispenser une formation collective à ses équipages d'aéronefs, l'Aviation royale canadienne (ARC) s'est demandé si sa méthode d'analyse de la formation pouvait être améliorée non seulement pour les individus, mais aussi dans le cadre d'équipes et d'équipes d'équipes. À l'heure actuelle, l'ARC utilise le Système de l'instruction individuelle et de l'éducation des Forces canadiennes (SIIEFC) pour cerner et combler les lacunes en matière de formation; cependant, d'autres modèles d'analyse pourraient mieux exécuter cette même fonction. Les besoins en formation du contrôleur interarmées de la finale de l'attaque (CIFA) avaient été analysés précédemment au moyen du SIIEFC, et plus récemment à l'aide d'une méthode différente, celle des compétences essentielles à la mission (CEM), qu'utilise le plus proche allié du Canada, les États-Unis. Ces analyses parallèles ont permis l'exploration des différences et des points d'intersection des systèmes, de même que la possibilité d'exploiter les forces de chaque système. Le présent document traite des caractéristiques des deux méthodes, de même que de leur application à la formation des CIFA, en observant les intrants et les extrants des processus, ainsi que leurs forces et leurs limites. Selon notre analyse, le SIIEFC couvre considérablement plus d'aspects de la formation avec une plus grande flexibilité que les CEM; toutefois, le processus d'analyse des CEM offre d'excellents résultats pour la structuration de la formation, notamment en ce qui a trait à la performance opérationnelle contextualisée et collective. En adoptant les CEM en tant

que type particulier d'analyse dans le cadre plus vaste du SIIEFC, il serait possible d'en tirer des avantages considérables.

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Collective Training; Education; Needs Analysis; ADDIE; CFITES; Mission Essential Competencies