Air Operations Center Intelligence, Surveillance, and Reconnaissance Division: Mission Essential Competency-based Training Analysis across the Decade (2005-2015)

Lisa Tripp*, Meghan T. Berlingo*
Air Force Research Laboratory
Wright Patterson Air Force Base, OH
Lisa.Tripp.1@us.af.mil, Meghan.Berlingo.1@us.af.mil

Michael Garrity, Michael J. Keeney
Aptima, Inc.
Woburn, MA
MGarrity@aptima.com, MKeeney@aptima.com

Chad Tossell*
Department of Behavioral Sciences & Leadership
USAF Academy, CO
Chad.Tossell@usafa.edu

ABSTRACT

The core tenet of the development of effective training content is to understand the foundational competencies associated with the development of expertise for each role within a domain and leverage this knowledge to tie the training content to the appropriate training objectives. For the past decade, the Air Force has leveraged a process that allows for the dissection of expertise into the core building blocks (i.e., knowledge, skills and experiences) required for the development of expertise, known as the Mission Essential Competency process. This process utilizes three workshops as well as broad spectrum data collection to capture empirical data in order to characterize expertise development and support the identification of training gaps. To date, the MEC process has been used across over 40 weapons systems. Decision makers within the training community have often asked about the longevity of the data collected (i.e., how frequent do the refresh intervals have to be to ensure the data is current?). This paper will discuss our analysis of the change over a 10-year period (2005-2015) in the Air Operations Center Intelligence, Surveillance and Reconnaissance Division across each component of the MEC data collection (overarching MECs, supporting competencies, knowledge, skills and experiences, and training gaps). This paper will provide the type of change (i.e., semantic versus functional) and degree of change to each component to address the question of determining appropriate MEC data refresh requirements.

ABOUT THE AUTHORS

Dr. Lisa Tripp is the C4ISR Training Research Team Lead in the Warfighter Readiness Research Division, Airmen System Directorate of the Air Force Research Laboratory**.** Her research focuses on improving the efficiency and effectiveness of training for Air Force Command and Control, Intelligence, Surveillance and Reconnaissance, Communications and Computers personnel. Dr. Tripp holds an M.S. in Applied Mathematics and Experimental Psychology, and a Ph.D. in Experimental Psychology from Washington State University.

Dr. Meghan T. Berlingo is the lead Research Psychologist on the C4ISR Training Research Team in the Warfighter Readiness Research Division at the Air Force Research Laboratory. Her research interests include increasing the efficiency and effectiveness of training for C4ISR professionals. She has her Ph.D. in Experimental Psychology from Washington State University.

Dr. Michael Garrity is the Executive Vice President of Government Programs at Aptima. He has more than a decade of experience developing and applying training and assessment methods and technologies in support of US and NATO organizations, spanning a variety of domains ranging from Fifth Generation Fighters and Unmanned Systems to operators and Senior Leaders within Air Operations Centers. Dr. Garrity holds a Ph.D. in Industrial and Organizational Psychology and a M.S. in Applied Psychology from Clemson University, and a B.S. in Psychology from Appalachian State University. He is a member of the American Psychological Association, the Academy of Management, and the Society for Industrial and Organizational Psychology.

Dr. Michael J. Keeney has managed and performed over 40 Mission Essential Competency projects. During military service, Dr. Keeney re-engineered two blocks of technical instruction, reducing student attrition while enhancing the value of the instruction, and his improvements to selection tests and a second technical course resulted in selection for an Air Force-level award. Dr. Keeney holds a Ph.D. in Industrial/Organizational Psychology from the University of Akron, a M.A. in Psychology from The University of Akron, a B.A. in Psychology from The University of Maryland, and an A.A. in Technical Management from the Community College of the Air Force. He is a member of American Psychological Association and the Society for Industrial and Organizational Psychology.

Major Chad Tossell, Ph.D. is an assistant professor and the director of research of the Department of Behavioral Sciences & Leadership, United States Air Force Academy. His research interests include topics in training, mobile computing, and human-machine teaming. He received his Ph.D. in Psychology from Rice University.

*The views expressed in this article are those of the author and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the U.S. Government.

Air Operations Center Intelligence, Surveillance, and Reconnaissance Division: Mission Essential Competency-based Training Analysis across the Decade (2005-2015)

Lisa Tripp, Meghan T. Berlingo
Air Force Research Laboratory
Wright Patterson Air Force Base, OH
lisa.tripp.1@us.af.mil, meghan.berlingo.1@us.af.mil

Michael Garrity, Michael J. Keeney
Aptima, Inc.
Woburn, MA
mgarrity@aptima.com, mkeeney@aptima.com

Chad Tossell
Department of Behavioral Sciences & Leadership
USAF Academy, CO
Chad.Tossell@usafa.edu

INTRODUCTION

Expertise development has been an active area of study in the cognitive psychology literature for over three decades (e.g., Chase & Simon, 1973; DeGroot, 1978). The study of expertise focuses on identifying the key characteristics that separate superior performers from less superior performers within the same domain (Ericsson & Smith, 1991). Throughout the decades, researchers have been trying to isolate the factors associated with the development of expertise. These studies have investigated a vast array of intrinsic and extrinsic factors ranging from working memory span to personality to intelligence (Kelley, 1964; Sternberg, 1982).

While still today there is no consensus on the complete set of factors that lead to the development of expertise, cognitive work analysis approaches that seek to capture the knowledge, skills and experiences (KSEs) have proven to be effective at describing a large number of the characteristics of expert performance (Alliger, Beard, Bennett, & Colgrove, 2012). One of these cognitive work methodologies, the Mission Essential Competency (MEC) process, has been applied successfully to this end and has been discussed extensively in other work (e.g., Bennett, Schreiber, & Andrews, 2002; Alliger, Colegrove & Bennett, 2003; Alliger et al., 2012).

However, the longevity of MECs has not been assessed, and in fact, some researchers have even called into question the idea of stable job competence due the rapid improvements in technology prevalent in almost every work environment today (Ericsson, 2009). With training budgets always on the chopping block, and training's critical function in maintaining mission readiness, one big question remains 'What is the longevity of the MEC analysis?'. This paper will discuss our effort to begin to address this question by comparing data from 2005 and 2015 MEC analysis of an Air Force Command and Control organization, the Air Operations Center's (AOC) Intelligence, Surveillance and Reconnaissance Division (ISR-D). The goal is to provide an analysis to understand the influence of time on MEC constructs and the stability of the core knowledge and skills underlying competency for AOC ISR analysts across the decade of 2005 to 2015. This research represents an initial look into the types of changes that may occur in MECs across a decade and factors that influence selection of refresh intervals to maintain data validity.

BACKGROUND

Roughly ten years before the publication of this report, the above-mentioned division published an extensive series of papers on the AOC MECs (Alliger et al., 2003; Tossell, Garrity & Gildea). The MEC products were used to develop AOC computer-based training (Tossell et al., 2006), performance assessment capabilities, and a number of other training proficiencies. After 10 years, Air Combat Command funded a position requirements analysis using the MEC process to update the current constructs.

The process in which these gaps are identified is called MEC analysis. The MEC process was originally developed to provide job-contextualized work functions that describe higher-order competencies that a fully-prepared individual or team require for successful mission completion under combat conditions (Alliger et al., 2012). The original goal in creating the MEC process was to help improve the USAF Ready Aircrew Program (RAP[1]). As a result of the techniques success, USAF Chief of Staff General John P. Jumper mandated them to be conducted for all major USAF weapon systems. To date, MECs have been successfully applied to a wide variety of Air Force, Naval, Joint, Coalition, and civilian systems comprising airborne, remotely-operated, and ground-based systems that perform command and control (C2), tactical air control, intelligence, information operations, and leadership functions. The MEC process is used by the United States Air Force (USAF) to offer strategies for knowledge elicitation and validation techniques from subject matter experts (SME's) in order to develop a higher order model of competencies, knowledge, and skills (Alliger et al., 2007; 2012).

The MEC process is a data-driven cognitive work analysis approach used to identify critical competencies and requirements for training, as seen from the perspective of representative operators and separate from formally established requirements. MECs aid in the identification of opportunities to enhance performance through better training, the development of recommendations to correct training gaps and the development of performance measures of critical work functions. MECs examine high level functions, job contextualized and less general in most cases than competencies found in standard corporate environments (Alliger et al., 2012) and can be formally 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., 2003). Although MECs are commonly used for the development of training requirements for the United States Air Force, the objective is not to target minimum standards of performance for certification, but rather, to utilize a SME-centered iterative process that identifies performance and decision-making components that represent a completely competent operator or team (Colegrove & Alliger, 2002). These constructs are then validated across individuals with various levels of experience. The MEC construct is extremely versatile and can be customized to any given position, division, or airframe.

The MEC process also captures learning environments and experiences within those learning environments that are critical for expertise development. These learning environments range from classroom-based training to operational deployments. Capture of these learning environments and experiences is essential to developing a training pipeline that optimizes the efficiency and effectiveness of training while being replicable across the community. Identification of the set of learning environments which provides the breadth and depth of experience can be challenging.

For example, note that while classroom-based training at an USAF schoolhouse is highly replicable, training from operational deployments is the exact opposite. Operational deployments are problematic as a training venue for several reasons. First, it seems clear that it is not often desirable to deploy untrained individuals simply to allow them to receive the experience of being deployed. Second, deployments, unlike deliberately prepared training, may not consistently provide systematic feedback about performance, a condition which is essential for learning. Third, deployment opportunities are highly variable, which results in large differences in the knowledge and skills acquired. Finally, considering the many cutbacks in opportunities to deploy that are a result of draw-downs in overseas force sizes and the dynamic nature of current conflicts, deployments targeting allowing for the development of specific skills may simply no longer be available, regardless of its efficacy as a training venue. These types of challenges underscore the importance of research and development of innovative solutions and alternative approaches to train the same knowledge and skills to the larger community in a consistent and feasible environment.

Some additional benefits of the MEC methodology are its rigorous structure and empirical data heavy collection process. Additionally, the level of granularity at which the MEC questions are carefully constructed increases the longevity of the data. The focus is on the knowledge and skills at the process level versus the 'buttonology' level. For example, a knowledge item might capture being able to identify weapons fire in infrared imagery. However, being able to use a particular function of a particular software application would not be included. With this in mind, software application updates should not adversely impact the validity of the MECs over time. For this reason, the longevity of the MEC data and appropriate refresh interval was of particular interest.

[1] See applicable AFI 11-2MDS Vol 1, AFI11-2MDS Vol 1 Ready Aircrew Program (RAP) tasking memorandum, and/or MAJCOM Supplements.

METHODOLOGY

Data Collection Methodology

The MEC methodology involves a four phases, three workshops and survey administration to the targeted community which SMEs that have been recognized as experts in their respective positions are interviewed.

In Workshop 1, the primary objective is to identify overarching competencies known as MECs. MECs are "*Job-contextualized work functions that describe higher-order competencies that a fully-prepared individual or team requires for successful mission completion under combat conditions*" (Alliger et al., 2012). MECs are not abstract knowledge or general skills, but are demonstrated in the context of an actual mission or high-fidelity simulated mission that are performed in non-permissive environments (i.e., under wartime conditions).

The ability of the Warfighter to execute this MECs is dependent on the trainee's current knowledge and skills. In the MEC process, knowledge is conceptualized as information or facts that can be accessed quickly under stress; whereas, a skill is a compiled sequence of actions that can be carried out error-free under stress. Skill descriptions begin with an action verb. For example, a knowledge item for AOC ISR-D personnel is 'Knows how to interpret Commander's guidance, objectives, and tasks process'; whereas, a skill item is 'Able to develop Objectives and tasks from Commander's guidance'. Researchers work with SMEs to identify the level of proficiency required by position for each knowledge and skill item.

In summary, Workshop 1 captures the MECs as well as the start (i.e., when the MEC is first used or evidenced), end (i.e., when the MEC is no longer required), and purpose (i.e., why the MEC exists and the outcome of effective performance). It also documents the foundational knowledge and skills required for expert level execution of each MEC. The objective is to identify the fewest number of MECs that can cover all of the expertise relevant to the targeted roles and ensure that MECs are mutually exclusive and collectively exhaustive.

During Workshop 2, the primary objective is to capture the experiences and learning environments in which experts gained their knowledge and developed their skills. Experiences are developmental events that facilitate the acquisition of knowledge and/or skills, or allow one to practice a MEC under operational conditions. The knowledge and skill items are mapped to the experiences, and each experience is rated according to its relevance to each position and its value in developing each MEC. This workshop also allows us to capture the breadth of environments that afford trainees opportunities to develop expertise.

The next phase of the process is survey-based data collection. Individuals surveyed range from brand new Airmen to Commanders. The goal is to maximize the number of participants and obtain a range of data. The survey questions are geared towards identification of gaps between the expert determinations of the required proficiencies and current operators' proficiencies, as tied to their ability to obtain knowledge and skills via the available experiences.

The survey constructed includes questions such as the (a) importance of each experience in developing each MEC, (b) degree to which it is practical and possible to train each experience in various environments, and (c) average frequency of exposure to each experience in various environments. Each survey requires approximately one hour to complete.

Workshop 3 involves inviting a team of experts and trainers to aid in the interpretation of the raw survey data. When gaps exist in the data, experts and trainers attempt to identify possible causal factors and mitigation strategies. SMEs from each position are present during Workshop 3 and review the survey-based data collection results item-by-item. Data is broken down into specific roles. Roles with less than three respondents are masked to preserve respondent confidentiality. SMEs use these results and their personal expertise and experience to identify training gaps.

During the 2015 MEC refresh, the objective was to update and validate the 2005 MECs for the AOC ISR Division. In support of this objective, the MEC process was condensed. The primary objective was to execute the update while minimizing SME time away from operational missions. Therefore, the 2005 MECs were used as a starting point for efficiency (i.e., not starting from scratch). This allowed researchers to combine Workshops 1 and 2. We recognize that this is a limitation and could result in a finding of less change being identified then may have been the case had we started from scratch.

Participants

The data collection included six teams within the AOC ISR-D and a combined total of 49 roles. For the interview-based data collection, a minimum of one to two SMEs who could speak to each role were selected by their leadership based on their relative experience level in the position. Data were collected from a total of 119 respondents in 2005. In 2015, a total of 116 respondents completed MEC surveys. Participants in 2005 and 2015 were stationed in multiple base locations around the world with various levels of expertise ranging from Airman First Class to Lieutenant Colonel.

Comparative Data Analysis Methodology

The overall data was decomposed into MEC subsection analysis (i.e., the MECs, knowledge and skills, experiences, and gaps). Researchers, in conjunction with SME input when items were not identical, evaluated each individual item from the 2005 MECs was evaluated against all 2015 items to determine the degree of similarity. If two items were identical, no further analysis was performed. If no two items were identical, researchers identified and categorized the type of change.

Each change was categorized as either semantic, functional, added/deleted, or combined. *Semantic* changes are changes in the verbiage without changes in the underlying meaning. Frequently, these included increased detail of the knowledge and skill item. *Functional* changes are changes in the underlying process of accomplishing the objective. There were also items that were completely new, *added*, nor longer relevant, *deleted*, or *combined* to enhance the organization and clarity of the document.

Since the objective was to explore the longevity of the MEC data, specifically data that could be used to set training requirements and drive training content development, we also investigated the potential of the different types of changes to influence training content development.

Leveraging outdated data to build training content when changes are semantic may result in training content that is less clear than the trainer desires. Leveraging MEC data that has changed functionally can result in invalid training content and instruction of outdated processes. Not utilizing added MEC content results in trainees who may not have received all the training that they need. Utilizing MEC content which is no longer relevant (i.e., deleted change) results in wasted training. While clarification is important (i.e., semantic changes) due to the larger relative influence in training content development, we assert that it is the functional changes as well as the added and deleted items that should drive the determination of the best MEC refresh interval.

To address the question of the degree of change in the MEC content across the decade, descriptive statistics were calculated to identify the percentage of each type of change in each subsection of the MEC content. The high impact changes, functional as well as added and deleted items, were also assessed independently from other types of changes (e.g., semantic changes).

RESULTS

The ISR-D MEC data from 2005 and the refresh in 2015 by subsection. In terms of the knowledge and skills (KS's) required to perform the job from 2005 to 2015, there were a total of 103 KS's recorded across the decade that were thought to be crucial for job performance. Of these 103 KS's, 39 changed across the decade. Of these changed items, 38% were absolute changes (i.e., new, deleted, or functional changes); and 17% were minor changes (i.e., semantic or organizational changes; see Figure 1). Of these changes (both minor and absolute), 26% can be categorized as semantic, 5% as organizational, 5% as functional, 33% as additional, and approximately 16 % as deleted or combined.

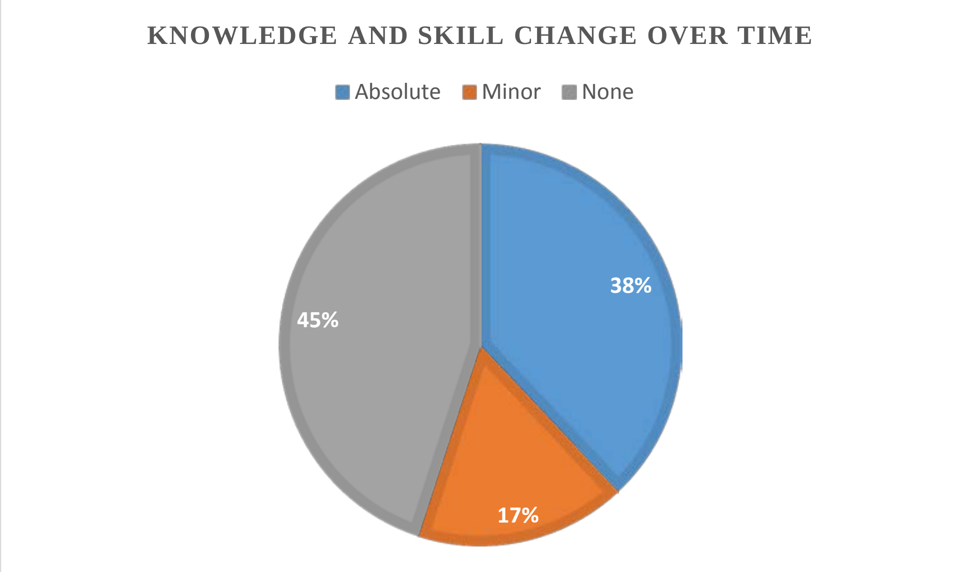

Figure 1. Knowledge and skill change over time

There was a 51% change in critical experiences necessary for expertise development. Of these changes, 54% of were added and 46% were removed across the decade.

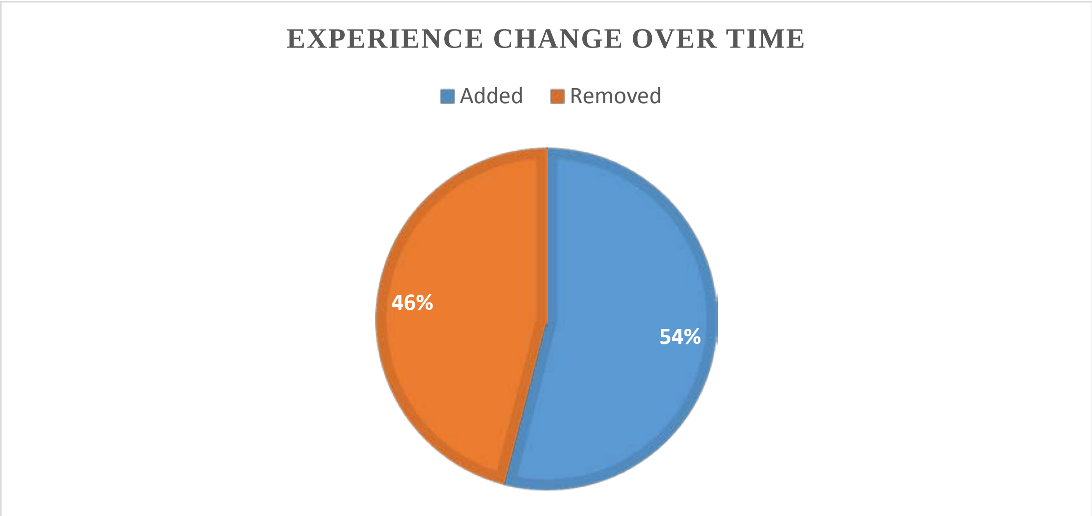

Figure 2. Experiences change over time

In order to analyze the gap data, SMEs evaluated the survey-based data and determined whether the data indicated a gap, potential gap, or no gap. For the comparative analysis, if at least one team indicated that there was a gap or potential gap, researchers counted it as such. In 2005, there were 25 experiences for which SMEs identified a gap, 34 potential gaps, and one experience in which no team had a gap. In 2015, there were only 10 experiences for which SMEs identified a gap, 20 identified potential gaps, and 37 experiences in which no team had a gap. Note that due to the large number of additions, the values themselves are not directly comparable. However, it is notable that while the number of experiences identified as valuable for gaining expertise went up substantially, the experiences which were considered gaps decreased significantly. To clarify, the number of experiences that SMEs identified as critical to the development of expertise increased from 60 in 2005 to 67 in 2015. However, the experiences identified through the survey data gaps in the existing training pipeline decrease from 25 in 2005 to 10 in 2015. In 2005, 42% of all the experiences were identified as gaps, meaning that trainees did not get the opportunity to experience them, 56% were potential gaps. In contrast, in 2015, only 15% of the experiences were identified as gaps and 30% were identified as potential gaps (see Figure 3).While there are more experiences overall in 2015, there is also a higher number of individuals and teams in the community that are getting the opportunity to learn from these experiences. Overall, this is potentially indicative of advances that have been made in training over the decade and/or opportunities to gain the expertise due to the current experiences available in today's conflicts. While this gap decrease may appear to represent a potential success in training on the surface, over half of the 2015 gaps were identical to gaps identified in 2005; this will be expanded on more in the discussion.

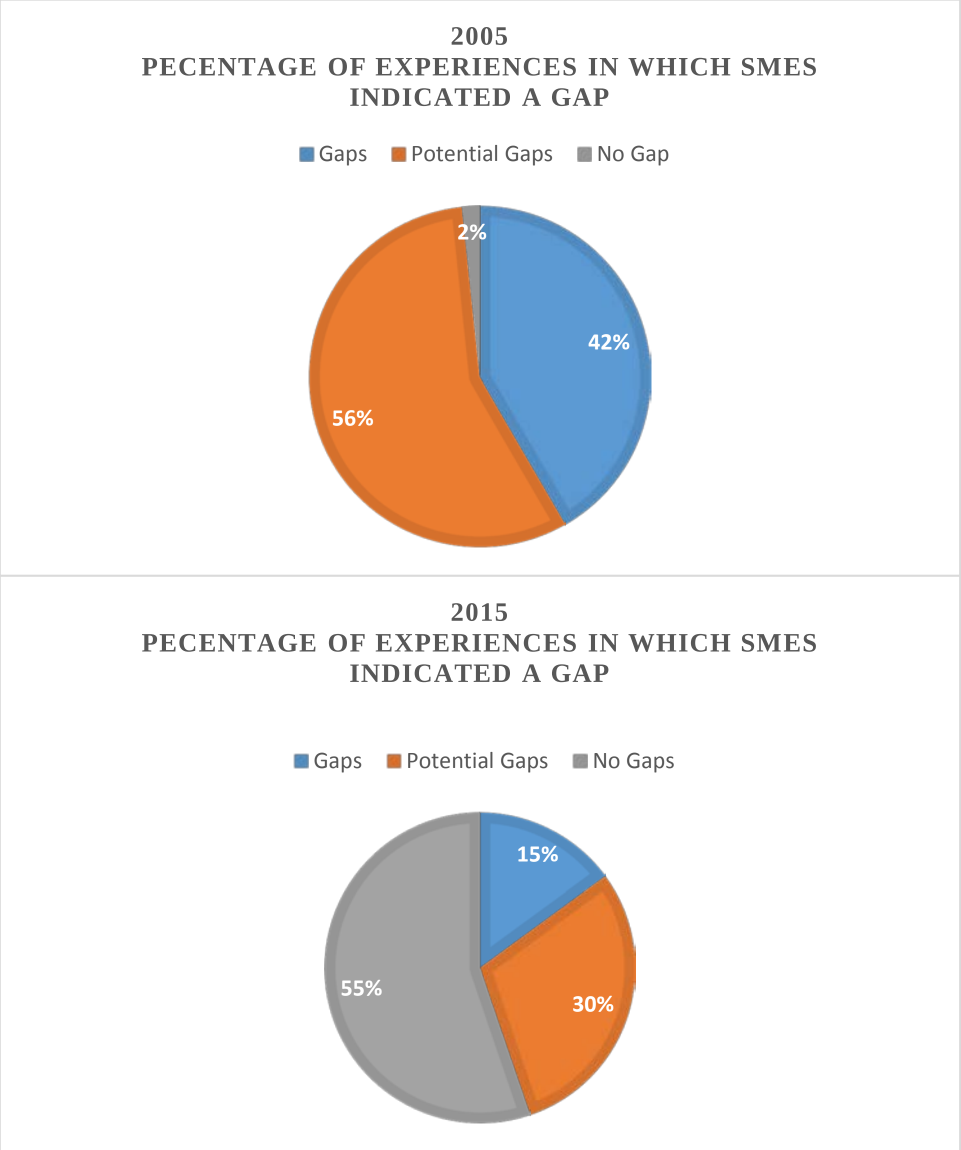

Figure 3. Training gap change over time

DISCUSSION

The MEC process has been broadly used to identify training requirements and associated gaps towards enhancing mission readiness. Originally, MECs were defined for the ISR-D immediately following the AOC being characterized as a weapons system. They were used to determine training tasks and enable training exercise development, among a number of other activities. Since then, the ISR-D has kept many of the same roles and functions within the AOC though technologies, operating systems, enemies, and other sociocontextual changes took place.

At the knowledge and skill level, changes were widespread with the most prevalent type of change being additions. This delta represents critical training content that, without a refresh of the MECs, may not have been identified as a training requirement. In the area of developmental experiences, again the most prevalent type of change was addition. These are core developmental experiences that are necessary for expertise development in today's operational environment that were determined not critical, not available, or not emphasized in the original data collection effort. It is expected that the changes that come with time (including operational environments, technology, etc.) will also subsequently change the knowledge, skills and experiences required for expert performance.

The gaps identified via the MEC analysis are arguably the most valuable aspect. They allow trainers to identify gaps in their courses and other training venues. They provide exercise planners data on the true needs of the community to target resources and effort towards areas that are in the most need. Finally, they drive research and development of simulation-based environments to season Airmen through building environments that are too dangerous, critical but infrequently encountered, or less applicable to today's conflicts but critical for readiness in the future.

Indeed, the gaps are the portion of the MEC analysis trainers and researchers work hard to attempt to mitigate over time. After a decade, while there were less gaps, 25 in 2005 as compared with 10 in 2015, over half of the 2015 gaps were identical to gaps identified in 2005. Despite all the efforts made over the decade, why do these gaps persist? At the broadest level, several factors could have driven the training shortfalls:

- *Downsizing*: The military community relies on strong partnerships between active duty, guard and reserve, civilian and contractor personnel to maintain their base of expertise. Generally, the active duty community fulfills the need for breadth; while the full-time guard and reserve, civilian and contractor personnel fulfill the need for depth. Over the past decade, there has not been a single segment of this team that has not been adversely affected by downsizing. This leads to lower levels of personnel retention and higher turnover. This means training gaps that take a longer and persistent effort to address via long-term research and development, organizational culture changes, and long-term partnerships with outside agencies, are challenging to address, as they require positive hand-off and advocacy between each rotation of personnel.

- *High turnover*: In addition to downsizing, the utilization of active duty military personnel leads to high turnover. While high turnover is generally considered to be a negative in the civilian sector, in the active duty community, breadth of experience is considered essential. As such, military personnel move every 3-5 years from one position to another. Additionally, the AOC does not have an identified group of personnel for the jobs within the ISR-D. Although intelligence analysts do generally spend their career doing some type of intelligence work, their stints in AOCs can last anywhere from one to five years. As with downsizing, high turnover influences the ability of the organization to address longer lead time issues.

- *New mission contexts*: As new mission contexts change and we prepare for new operational environments with distinct and ever emerging threats, the KSEs required for expert performance within these environments can also shift. For example, the recent military focus shift from counterinsurgency to contested and degraded operations is resulting in many changes to training programs.

- *Technologies*: Each time new technologies are transitioned, they have the potential to drastically change the concept of operations for the operational environment. When this occurs, it can influence the associated MECs. However, the level of granularity at which the MEC data is captured is designed to enhance longevity. Since the utilization of individual systems and applications is rolled up into high level, frequently no changes are necessary. For example, instead of a skill item being listed as "develop a product for a customer using Power Point", the item may be "develop a product for a customer using the operational standard application to ensure interoperability with the customer capability." Therefore, it is primarily during technology transitions in which the underlying process is modified and MECs need to be re-evaluated for relevance.

Overall, it is important to mention that although the MEC methodology has been implemented in a variety of career domains across the DoD, the results from this exploratory comparison from one domain within the Air Force intelligence community should not be generalized across other domains such as the fast-jet, Joint Special Operations Command, Joint Terminal Attack Controller, etc. It is conceivable that information-centric domains, such as the intelligence community, will undergo faster and more rapid change due to the constant influx of new technology which can influence underlying processes or change roles within teams. Further research is necessary to recognize whether similar patterns of changes exist in other communities.

CONCLUSION

In answer to our question of whether the decade long refresh interval was too long, based on the data, we'd argue yes. These results indicate that there were substantial changes to the core building blocks (i.e., knowledge, skills and experiences) required for the development of expertise. While it is recommended that additional longitudinal analyses such as this one be conducted prior to institutionalizing any major change in the way training gap analysis is conducted, preliminary results indicate that a decade MEC refresh interval will result in major changes to the content, especially in the area of added content to the KSEs, while overall competencies remain relatively stable even across a decade.

Overall, the most prevalent changes across the KSEs were added content. Capturing this added content is critical to ensuring trainees are getting all the content they need for mission success in a non-permissive environment. Overall, the changes in the gap data tell an optimistic picture regarding the progress of training for the AOC ISR-D, showing substantial reductions in the gaps despite an increased number of experiences required for the development of expertise in a position within a team. However, of the gaps identified in 2015, over half persisted from 2005. This indicates that there is still work to be done to ensure the AOC ISR-D has the training they need to be ready for current and future operational environments.

For example, a portion of these gaps dealt with working with external agencies. Due to the locus of control being shared between the trainer and the external agencies, these types of gaps can be inherently challenging to tackle. Additionally, many of these gap statements involve experiences that a trainee is unlikely to get in the current operational environment. This can be due to the role a position plays within the organization. For instance, certain functions may leverage a reachback organization and not be performed internally to the AOC. At today’s battle rhythm for today’s adversaries, experience on those particular functions may be de-emphasized during training due to limited time and budgets. However, these experiences become substantially more important as the USAF pivots towards ensuring readiness, even in contested and degraded operational environments, where complete reliance on a reachback organization can be detrimental to mission success. Additional research is recommended to understand these factors more clearly.

Primarily changes in content stemmed from deployment of new capabilities when those new capabilities changed the underlying processes. For example, changes in operational partners, such as the standup of reachback organizations to provide increased support, are often accompanied by changes to concepts of operations and tactics, techniques and procedures, and even changes to the perspective of the role of a process within a position. One of these changes, for example, is the word “assemble”, which was used more frequently in 2005 compared to the new term “analyze” in 2015. This change was not classified simply as a semantic change given it has changed the role of the operator in mission contexts.

Indeed, the Intelligence Community (IC) has placed considerable emphasis on analysts doing more than passive collection, processing, and dissemination of intelligence data. Technology advances have automated some of these lower-level functions. Thus, analysts have been encouraged and mandated to analyze the data more closely towards adversarial modeling, understanding the implications of particular activities, and synthesizing the data vis-à-vis higher-level mission goals and inertia.

This assessment of change across the decade provides a unique perspective on how the focus of ISR within USAF C2 has changed. More importantly, longitudinal analysis allowed us to identify persistent gaps which provide a clear vector on where we need to focus our research and development and organizational change emphasis to ensure operational readiness in the future.

REFERENCES

Alliger, G. M., Beard, R., Bennett, W., & Colgrove, C. M. (2012). Understanding mission essential competencies as a job analysis method. In M. A. Wilson, W. Bennett, S. G. Gibson, & G. M. Alliger (Eds.) *The handbook of work analysis: Methods, systems, applications, and science of work measurement in organizations* (pp. 603-624). New York: Routledge.

Alliger, G. M., Beard, R., Bennett Jr, W., Colegrove, C. M., & Garrity, M. (2007). *Understanding mission essential competencies as a work analysis method.* GROUP FOR ORGANIZATIONAL EFFECTIVENESS (GOE) ALBANY NY.

Alliger, G. M., Bennett, W., Colegrove, C. M., Garrity, M. J. (2007). *Understanding Mission Essential Competencies as a Work Analysis Method*. In: Defense Technical Information Center (DTIC).

Alliger, G. M., Colegrove, C. M., Bennett, W. Mission Essential Competencies (2003). *New Method for Defining Operational Readiness and Training Requirements*. In: 13th International Occupational Analyst Workshop. San Antonio, TX.

Bennett Jr, W., Schreiber, B. T., & Andrews, D. H. (2002). Developing competency-based methods for near-real-time air combat problem solving assessment. *Computers in Human Behavior, 18(6),* 773-782.

Chase, W. G., & Simon, H. A. (1973). Perception in chess. *Cognitive psychology, 4*(1), 55-81.

Colegrove, C.M. & Alliger, G.M. (2002). *Mission Essential Competencies: Defining combat mission readiness in a novel way*. In: NATO RTO Studies, Analysis and Simulation Panel (SAS) Symposium. Brussels, Belgium.

Ericsson, K. A. (2009). *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments*. Cambridge, MA: Cambridge University.

Ericsson, K. A., & Smith, J. (1991). *Toward a general theory of expertise: Prospects and limits.* Cambridge University Press.

De Groot, A. D. (1978). *Thought and choice in chess*. Amsterdam: Amsterdam University Press.

Kelley, P. L., & Kleiner, W. H. (1964). *Theory of electromagnetic field measurement and photoelectron counting. Physical Review, 136*(2A), A316.

Sternberg, R. J. (1982). *Handbook of human intelligence.* CUP archive.

Tossell, C., Garrity, M. J., Gildea, K. (Undated). *Developing Expertise at the Operational-Level of Warfare*. Unpublished working paper.