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AIRCRAFT MAINTENANCE WITHIN THE TWENTY-FIRST CENTURY RCAF

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ABSTRACT

"*Such is the Pathway to the Stars*"

From its beginning, Canada's air power capability has undergone significant alterations since its beginning and it is now it must alter its core values to meet emerging twenty-first century challenges. The aircraft maintenance community is an essential component to enable the RCAF's ability to accomplish its mandate articulated by the Canadian National Defence Policy "Strong, Secured, Engaged." By using lessons learned from its past and from allies, the RCAF's air maintenance community must continue to embrace the new technologies and advanced methodologies to lead changes in the maintenance practices. New training attitudes and an emphasis in the education and development of agile critical thinkers will be one the centre piece of the process with openness to new ideas and innovative ways of thinking if it is to be prepared for role in enabling the RCAF's prosecution of twenty-first century air power on behalf of Canada

LIST OF ABBREVIATIONS

1 CAD - 1 Canadian Air Division

A4 Maint - A4 Maintenance Director

AAF - Afghanistan Air Forces

ACS - Aircraft structure technicians

ACSO - Air combat system officers

AF9000+ - RCAF quality management system

ADM (Mat) - Assistant Deputy Minister (Material)

AEO - Aircraft Engineering Officer

AERE - Aerospace officer

Air Guard - United States Air National Guard

AWS - Air weapons technician

AMS - Air Maintenance Squadron

AM Stds - Aircraft maintenance standards

AMSET - Aircraft maintenance standard evaluation team

AM Sup - Air Maintenance Superintendent

BAMEO - Base Aircraft Maintenance Engineering Officer

CAG - Capability advisor group

CASA - Australian Civil Aviation Safety Authority

CBT - Competence-based training

CFRG - Canadian Forces Recruiting Group

CFSATE - Canadian Forces School of Aerospace Technology and Engineering

CFTOs - Canadian Forces Technical Orders

CO - Commanding officers

CMP - Chief of Military Personnel

CWO - Chief Warrant Officers

CoC - Chain of command

CTOL - Conventional take-off and land

EASA - European Aviation Safety Agency

FAA - Federal Aviation Administration

FE - Force Employment

FG - Force Generation and

FLYPRO - Flying program

FOC - Full operational capability

FRP - Force reduction plan

FWSAR - Fixed Wing Search and Rescue

FY- Fiscal year

GAMA - General Aviation Manufacturers Association

P11 - RCAF quality management system

OJT - On the job training

JTF - Joint Task Force

ISR - Intelligence, surveillance, and reconnaissance

NAA - National Aviation Academy

NAV - Air navigators

NCM - Non-commissioned members

NCO - Non-commissioned officers

MND - Minister of National Defence

MOB - Main operation base

MPRR - Member's personal record resume

MWO - Master Warrant Officers

NORAD - North American Aerospace Defence

OEM – Original Equipment Manufacturer

ODB - Officer Development board

OPD - Officer professional development

PEO - Professional Engineers of the province of Ontario

PME - Professional Military Education

QMS - Quality management system

RAWC - RCAF Aerospace Warfare Centre

RCAF – Royal Canadian Air Force

RN - British Royal Navy

RPA - Remotely piloted aircraft

R&D - Research and development

SAMA - Senior Air Maintenance Authority

SAMEO - Senior Aircraft Maintenance officer

SAR - Search and Rescue

SDE - Senior Design Engineer

SOA - Senior occupation advisor

Sqn – Squadron

STOVL - Short take-off but arrested recovery

TAM - Technical airworthiness manual

TFI - Total Force Integration

TpSAR - Transport and SAR

TST - Technical support team

USAF - United States Air Force

USN - United States Navy

VR - Virtual reality

WComd - Wing Commander

WSM - Weapon system manager

CHAPTER 1: INTRODUCTION

Aircraft maintenance due to its inherent nature has always been entrenched in the daily operational routine of armed forces aviation. It criticality resides in the division between the realms of operations and logistical support undertakings. It is a world mastered by maintenance officers and personnel ensuring aircraft are airworthy and mission capable. Doctrinally aircraft maintenance resides in the support territory but it can be easily argued that given its close proximity and direct effects on aircraft operations, it has a privileged relationship with operations and aircrews. Therefore, the aircraft maintenance community falls within the logistical support nexus but its tremendous impact of operations obliges it to be closely aligned with and thoughtfully responsive to the direction the Royal Canadian Air Forces (RCAF) in any future endeavours.

The focus of this research project will be to determine the characteristics required for the aircraft maintenance community to meet the future RCAF operational concepts by enabling the optimization of its structure, training and development, and recruitment and loyal. The research will review past and current experiences and documentation of Air Maintenance Squadrons (AMS) and flying Squadrons, which is defined by squadron-based maintenance, primarily from the RCAF. The United States Air Force (USAF), United States Navy (USN), United States Army Aviation, United States Air National Guards (Air Guards), British Royal Navy (RN) Fleet Air Arm and the Afghanistan Air Forces (AAF), and civilian aircraft maintenance organizations such as the Australian Civil Aviation Safety Authority (CASA) and General Aviation Manufacturer Association (GAMA) will also be studied to capture key innovations and new concepts being implemented with respect to structure, recruitment, personnel development and maintenance philosophy. This approach and method will provide a sound quantitative assessment

of the current state of the RCAF maintenance and its personnel, and how best can the community orient itself to generate the required capabilities to support the RCAF in the future.

This study will argue that the RCAF maintenance community needs to determine its current capability gaps and assess how it can make itself prepared to address the challenges of the twenty-first century RCAF's operational concept. In particular, it will address the challenges of a maintenance structure that has not really changed since the early 1990s, and the modernization of the maintenance philosophy. It will analyze the way the RCAF maintenance community develops and trains it workforce of maintenance professionals with expectations of higher education and enhanced critical thinking, while dealing with recruitment, loyalty and dedication challenges.

With the strategic guidance provide be the *Strong Secure Engaged – Canada's Defence Policy* released in 2017 by the Minister of National Defence (MND), the RCAF has been given a vector to align itself in order to enable the roles and missions defined within its responsibilities.[1] With an outcome based approach in conjunction with the defined missions of the CAF as stated in the *Strong Secure Engaged – Canada's Defence Policy*, the RCAF can set the guidelines to generate the required air power capabilities in order to fulfill domestic and international mandates.[2] These mandates must be performed by respecting the core principles of air safety and airworthiness. From these mandates emanates expectations and associated roles with new investments in the RCAF's capabilities which will alter the aircraft maintenance world. Amongst the new detailed acquisitions in the foreseeable future are the replacement initiatives for the older fleets of the CF-188 Hornet, CC-150 Polaris, CC138 Twin Otter, CP-140 Aurora, CC-295 and

[1] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. Minister of National Defence. 2017. 37

[2] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 38

remotely piloted aircraft (RPA).[3] Furthermore, modernization, life extension, and upgrades of numerous current navigation, flight management, control, and structural systems within the existing fleet will involve the maintenance community from a research and development (R&D) and sustainment initiatives.[4]

This study will focus mainly of first and second operational squadrons and units, and how to generate competent maintenance professionals able to cope with the upcoming future demands. However by taking this approach comprehensive manner other extremely influential spheres with the maintenance community cannot be ignored. These spheres include the Assistant Deputy Minister Material (ADM(Mat)), the Director General Aerospace Equipment Program Management (DGAEPM), and 1 Canadian Air Division (1 CAD) A4 Maintenance Director (A4 Maint). All these organizations are parts of the greater maintenance community and play crucial roles in its abilities to deliver air power domestically and internationally.

This research study recognizes that all modern air forces from democratic and free societies are facing similar challenges in their ability to plan and foresee what the future holds. Budget constraints, political and national requirements, and economical perspectives, all play crucial roles in how militaries, including air forces, have to navigate effective procurement processes and implementation undertakings.[5] All air forces due to their reliance on and extreme sensitivity to technology are traditionally more costly to acquire and maintain over the lifespan of a fleet.[6] With the significant costs, the procurements of new fleets are often political "hot potatoes" that become election topics usually battling parties on both sides of the requirements.

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[3] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 38

[4] Ibid. 38

[5] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 1

[6] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 3

The reality is that Canada needs air power that provides the means to meet its defence requirements for its national interests. Given its size, geography, history and way of life, Canada has to "Canadianize" its air power accordingly and not simply blindly emulate any other counties' air powers elements.[7] Consequently all Canadian air power elements must possess Canadian aspects, including aircraft maintenance. With this reality, Canada must take decisions based on its own past combined with lessons learned from allies with similar challenges to not thoughtlessly shadow larger air forces with the understanding of their realities and determine what can be preferred for the RCAF. Educated and informed decisions through experience always yields better results.

The research project will be divided into four parts. Chapter 2 will review the structure and concept of the RCAF's maintenance organization and its inner workings. It will begin by reviewing the current organizational concept and how it came to be in existence by considering the reasons that led to the division of organizations such as BAMEO, and the subsequent creation of AMS and SAMEO. It will discuss the advantages and disadvantage of this type of organizations with respect to the expectations of the twenty-first century. This chapter will also review the lessons learned from the United States Air Force (USAF), British Royal Navy (RN) Fleet Air Arm and the United States Air National Guard to see how applicable they are to the RCAF and its own challenges when it comes to personnel, equipment, and maintenance philosophy. Despite the fact that the RCAF is not quite as large in size to the USAF and RAF, the structures and mentalities are similar, and thus initiatives stemming from lessons learned can be applied to the RCAF, through a Canadian nuance, with a certain degree of potential success.

[7] Gray, Collin S. Air Power for Strategic Effect. Air Forces Research Institute. Air University Press. 2012. 301-302

Furthermore, these air forces also have to contend with the political and budgetary influences from national and international entities. This is also the Canadian reality.

Chapter 3 will address the education and training required to enable the maintenance personnel and organizations to fulfill their mandate within the RCAF operational concepts. The research project will review from a holistic approach what type of education and training is required for maintenance personnel to be effective leaders and develop professional mastery of technical and airworthiness standards. This approach will consider what and how the RCAF can use the available lessons learned to position itself in a better position for the future. Centralized control and decentralized execution is a fundamental tenet of air power and is encouraged and practiced in most maintenance areas largely due the airworthiness responsibilities that differ from the traditional military chain of command (CoC). Airworthiness responsibilities enable trained, authorized, and qualified technicians, non-commission members (NCM), to effective rectify deficiencies on aircraft and to discuss directly with aircrew, non-commissioned officers (NCO) or officers. Chapter 3 will also demonstrate how shifts in education using modern technology and forward-thinking instructional method, career planning, and long term focus on members can yield great results for the organization as a whole.

Chapter 4 will discuss the impact of recruitment, loyalty and dedication of aircraft maintenance members and how different type of maintenance organization influences the process. Although subjective in nature, the type of maintenance organization in place has affected the loyalty and dedication of the personnel to the extent of improving and decreasing serviceability and availability of aircraft in certain squadrons. Along the same logical path, this chapter will also outline the advantages and disadvantages of having centralized maintenance organizations such as Air Maintenance Squadron (AMS) to having a decentralized maintenance

organization such as a maintenance flight under the Senior Aircraft Maintenance officer (SAMEO) within a flying squadron (Sqn) such a 435 Squadron (Transport and Rescue) Winnipeg. Both types of concepts have been used in the RCAF over the years and have proven advantages and disadvantages that have greatly influence how the recently acquired fleets' maintenance organization were structured. The nexus of loyalty and dedication and how to promote it within a maintenance organization and its personnel emanating from different generations will be essential considerations in this chapter as they relate to the future of the maintenance community. Disregarding these aspects would be a failure in leadership in the RCAF's organizational learning culture. Furthermore, the chapter will discuss why people join and why members stay within the RCAF, and how to adequately target reasons to solve them. This will be done using lessons learned from other militaries, and civilian airlines and manufacturers.

Despite the large amount of references on the subject, the current author's knowledge and experience as an aerospace officer (AERE) will be leveraged to bridge the gaps in certain specific areas where publications and review are limited with respect to the RCAF maintenance organizations and activities. This experience includes being a maintenance officer on the CC130 E, H, and HT Hercules for domestic and international operations in the Middle East and Afghanistan. It also includes having been the CO of the 19 AMS Comox, which provided second line and limited first line support to the CC115 Buffalo, CP140 Aurora, CH124 Sea King, and CT114 Tutor. His experience also encompasses being the Aircraft Engineering Officer (AEO) and Senior Design Engineer (SDE) for the fleet of CC130 E, H, and HT Hercules under the weapon system manager (WSM) in ADM (Mat). And finally, his experiences also include

having been posted at 1 CAD A4 Maint as a member of the A4 Maint Readiness section of transport and SAR fleets (TpSAR), aircraft maintenance standards (AM Stds), and as a lead auditor for AMSET audits. Levering on this knowledge of several fleets will allow an enhanced and rounded approach to this research paper. The author calls the fundamental relationship between the operational, 1 CAD A4 Maint, and DGAPEM as the "*Holy Trinity of the Maintenance World*". This holy trinity has to be understood by all maintenance personnel to fully exercise the whole spectrum of capabilities to appropriately enable success in the RCAF's operations. Furthermore, the author is a Professional Engineer of the province of Ontario (PEO) since 2009, which provides a bridging perspective between both professions and how they relate to each other.

CONCLUSION

With *Strong, Secure, Engaged* outlining the upcoming expectations and goals for the RCAF in the future, the aircraft maintenance community has to ensure it remains an effective enabler of success in the future.[8] The support will span across all spheres of the community but primarily at the first and second line operational squadrons for tactical level activities. This research project will review all the areas of the aircraft maintenance community when seen through the lenses of organizational structure, education and training of personnel, loyalty and dedication, and lessons learned from other Air Forces with similar budgetary and political constraints.

This is truly the challenge of the RCAF and many similar sized air forces which have to balance the needs versus the resources availabilities. The true test is for air power entities to be able to generate sufficient military capabilities to defend national interest on the domestic and

[8] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 38

international fronts without seeking international help; a Canadian truth.[9] Taking these factors into consideration, the Canadian Armed Forces, including the RCAF and its aircraft maintenance community, must be able to generate and sustain an all-rounded military capable of surging and fulfilling all mandates with significant budget constraint intertwined with political influence.[10] The maintenance community is affected by the same limitations when it comes to deliver enabling capabilities in support of the RCAF operational concepts while maintaining its fundamental principles of airworthiness and maintenance standards.[11]

[9] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 2

[10] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 3

[11] Sajan, Aleem. The Long Game: Institutional Transformation within the Air Maintenance Community. JCSP 44 Exercise Solo Flight. 2018. 21-22

CHAPTER 2: STRUCTURE AND WORKINGS OF THE MAINTENANCE COMMUNITY

INTRODUCTION

This chapter will discuss the know difference between the types of maintenance organizations in the RCAF and how to change the way they operate to be better suited for the twenty-first century by looking at lessons learn for the CAF's part but also for other air forces. In order to proper look into the future, this study will acknowledge the tremendous change that the Canadian air power capability has underwent since end of the Second World War and Cold War, which have left mark in the organization up to this day by establishing basic air force tenets.[12] The tenets are that air warfare is indivisible in nature, that it possess an independent purpose of air power to enable strategic warfare, and that air superiority is a success factor in undertaking any offensive action.[13] The current CAF structure following the unification in 1968 that incorporated all services into a single armed force, and the re-establishment of the RCAF and RCN in the 2010s showed the importance of having a focused command structured within all the advantages of a single military entity. Despite the in-service contracts and the strong Canadian Army influence in all military spheres, this structure has been essential in ensuring all military air assets are procured, maintained, and managed to the same airworthiness standards and maintenance principles. Airworthiness standards and maintenance tenets are the bedrock of the maintenance community and undoubtedly the most important principles. Even with some key individuals such at Professor Robert Farley form the University if Kentucky's Patterson School

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[12] James, Stephen. *The Air Force's Cold War Struggle with its National Purpose*. 3rd Air Force Historical Conference 1997. Winnipeg. Department of National Defence. Office of Air Force Heritage and History. 1998. 80-81

[13] James, Stephen. *The Air Force's Cold War Struggle with its National Purpose*. 3rd Air Force Historical Conference 1997. Winnipeg. Department of National Defence. Office of Air Force Heritage and History. 1998. 80.

of International Affairs and retired British Army Colonel Tim Collins, as reference by James Hasik, calling for the dissolution of national air forces for the US and the UK with the plan of dividing and distributing all air assets amongst the other services, this research study and author will advocate for the undeniable benefits of the Canadian model in promoting the maintenance principles under a single command within a single Canadian military.[14] This aspect ensures the primacy of operations while taking into account the air element residual authorities, especially for deployed operations under the Joint Task Force (JTF) concept. Without a single command of all air assets, the risks of having RCN and CA develop, maintain, and support aircraft maintenance and engineering expertise would be unrealistic given the Canadian military budgetary reality.

For the medium size of the Canadian military, the concepts of having a single command work well. However, does it foster true openness towards an agile use of air power or does it institutionalize the air power element within the confined of limited flexibility to think, act and react freely outside the box as nearly all AERE officers are training and educated similarly within their fleets? The spectrum flexibility is wide with some fleets primarily supporting only one environment such as tactical aviation with the CA or multiple environment such as the CP-140 Aurora recently supporting all three services with intelligence, surveillance, and reconnaissance (ISR) capabilities, despite the fact that it was initially primarily used for maritime operations. This chapter will discuss the currently used organizational structure and how it finds its roots in the Wing restructuring in the 1993 program. It will then review the lessons learned from other air forces and civilian organizations to truly understand the challenges ahead and how to be ready to overcome them.

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[14] Hasik, *James. Mimetic and normative isomorphic in the establishment and maintenance of independence air forces*. Defence & Security Analysis. 2016. 254-255

THE CURRENT ORGANIZATIONAL STRUCTURE

The Wing restructuring of 1993 was triggered by the reduction in personnel and military budget in the early 1990s.[15] This was the new re-implementation of the old Wing concept which generated the creation of Air Maintenance Squadrons from the Base Aircraft Maintenance Engineering Officer (BAMEO) organization, therefore providing a more focused fleet approach on aircraft maintenance with the SAMEO and AMS structure that are so familiar to CAF's members today.[16] Under the previous construct, the BAMEO organization managed all base aircraft engineering and maintenance aspects on the base or wing, including some limited aspects of Construction Engineering sections, Electrical and Mechanical Engineering vehicle sections. All of it was done by different flights under a single authority. The BAMEO organization was generally headed by a Lieutenant Colonel Aerospace Engineer (AERE). Therefore, with the new organization, the newly formed aircraft maintenance organizations were solely focused on aircraft maintenance and associated activities at all levels of expertise and ranks.[17]

This approach was a good aspect to ensure proper leadership and directions were given in line with the maintenance and airworthiness realities. The same observation can be made with respect to other engineering sections such as EME and CE. This new revival enabled the aircraft maintenance structure to grow, develop, and adapt to the specific demands of each wings and fleets in Canada and overseas. This holistic, and even laissez-faire, approach generated divergence of ideology and stove-pipes grouping by fleets that are still felt today with in the vast majority maintenance communities. Each maintenance community has adapted and morphed to

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[15] English, Allan. *Command & Control of the Canadian Aerospace Forces: Conceptual Foundations*. Department of National Defence. 2008.67

[16] Canada. Royal Canadian Air Force. *1 Air Maintenance Squadron.* 2018. http://www.rcaf-arc.forces.gc.ca/en/squadron/1-squadron.page

[17] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 163

support their own flying and operational communities with limited interaction with other community; this was done with the stove-pipe mentality. There was no clear standards directed from 1 CAD A4 Maint policies, just a common understanding and ideological agreement based on broad notions on what maintenance organizations should resemble and aim towards. This approach allowed every maintenance organizations, including AMS and SAMEO flights, to become significantly different from the name of the positions, crews, sections, and responsibilities.[18] This opened approach of allowing each fleet of working in their own stovepipes of excellence would be duplicated several times over in the RCAF with the belief that each community would know what is best for itself, and therefore by allowing differences in applications aiming towards a common objective; it would conclude in generating a greater buy-it through empowerment and ownership of the success of the implementation.[19] It was truly a utopian belief that all maintenance organization would slowly morph into a single standard never materialized, mainly due to the prevalence of fleet insularism and dominant personality amongst maintenance personnel. The noticeable challenge with this approach is based on the core fact that the RCAF as a whole, including the maintenance community, is very fleet oriented, and thus not the fertile ground to foster common applications of notional concepts.

The aerospace maintenance community can be divided into five distinct fleets; tactical or land aviation, fighters, transport which include SAR, maritime, and material and a headquarters group.[20] Given the fact that many maintainers remain within the same fleet for a substantial part of their career, they never experienced other structures from other fleets, and thus only embraced

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[18] Canada. Royal Canadian Air Force. *Maintenance Policy – Aircraft Weapon Systems Maintenance – Aerospace Engineering and Maintenance Program Managements.* C-05-005-P02/AM-001. 2018. 3-4 to 3-15

[19] Canada. Royal Canadian Air Force. *Maintenance Policy – Aircraft Weapon Systems Maintenance – Aerospace Engineering and Maintenance Program Managements.* C-05-005-P02/AM-001. 2018. 3-4 to 3-15

[20] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 162-163

the structures that they have grown and known. In the early 2000s, the difference between each maintenance flight of squadron was such that even other RCAF trades such as pilots and air combat system officers (ACSO), formerly known as air navigators (NAV), were confused by the noticeable variance in every maintenance community, and thus desired a more standardized nomenclature and structure. Another powerful and influential factor in the standardization of the maintenance community was that the pilots and ACSOs were commanding officers (CO) of a flying squadron, which included SAMEO organizations, and thus experience difficulties in discussing maintenance issues with other flying COs.[21] Hence from these stated factors, differences in the structure, nomenclature, and responsibilities had to be addressed and rectified.

The seeds of change were planted in many key influential stakeholders. Hence around 2005, an initiative spearheaded by 1 CAD A4 Maint to standardize the maintenance organization started across the RCAF. This initiative was led by 1 CAD A4 Maint sections, and directed through amendments to maintenance policies such as P02, the RCAF quality management system (AF9000+) commonly known as P11, and messages incorporated in the maintenance policies.[22] This plan was also promulgated and promoted via the annually held Air Maintenance Standard symposium by key stakeholders as attended by the author in 2016 and 2017 in Winnipeg. The verification of the implementation of the changes was conducted during the AF9000+ airworthiness registration process and 60 month audit cycles of 1 CAD A4 Maint aircraft maintenance standard evaluation team (AMSET).[23] The initiative was successful and by

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[21] Based on the author's experience at 1 CAD AMSET and A4 Maint Transport SAR section from 2010 to 2012.

[22] Canada. Royal Canadian Air Force. *Maintenance Policy – Aircraft Weapon Systems Maintenance – Aerospace Engineering and Maintenance Program Managements.* C-05-005-P02/AM-001. 2018. 3-4 to 3-15; Canada. Royal Canadian Air Force. *Maintenance Policy – Quality Standard for Aerospace Engineering and Maintenance (QSAEM).* C-05-005-P11/AM-001. 2018. 1-1 to 1-5

[23] Canada. Royal Canadian Air Force. *Maintenance Policy – Quality Standard for Aerospace Engineering and Maintenance (QSAEM).* C-05-005-P11/AM-001. 2018, 1-5 to 1-8.

notionally standardizing all RCAF maintenance organizations it ensured newly created ones followed the same standards and nomenclature.

AMS COMPARED TO FLYING SQUADRONS

Rooted in the Air Force's major reorganization project in 1992, the air maintenance squadrons were born out of the BAMEO's organization on 1 April 1993.[24] Air maintenance squadrons have drastically changed since the last 15 years with the adoption of the "hub and spoke" concept in several wings such at 8 Wing Trenton and 14 Wing Greenwood. The concept of centralized maintenance under an AMS is in theory and approach makes sense from a quantitative perspective. Centralizing all maintenance personnel in an organization commander by an AERE LCol with direct access to other Wing COs and the Wing Commander (WComd) is very logical but in practice it generated several irrefutable challenges from serviceability and motivation aspects. In practice, the concept of centralized maintenance did not yield the expected results in numerous wings primarily due the lack of understanding from maintenance personnel on how their work directly impacted and enabled operations to be conducted.[25] Maintenance personnel were often uninformed of how essential their professionalism affected operations. Therefore, being confined to centralized maintenance organizations such as AMS would allow them to disconnect from the essential nature of their contribution to successfully achieving defined objectives and mandates. This reality was also a failure of effective communication plan at all ranks levels. The reality of a SAMEO organization or flight within a flying was

[24] English, Allan. *Command & Control of the Canadian Aerospace Forces: Conceptual Foundations*. Department of National Defence. 2008.67-68

[25] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 167

noticeability different and will be discussed further in the next section.[26] Also the challenge with respect to motivation will be addressed in chapter 4 of this research project.

Centralizing all maintenance activities under a single squadron can potentially lead to command and control issues. Specifically, in terms of the exercise of the full projection of power, other COs of flying squadron do not command and control the essential enabler to ensure their aircraft are airworthy and mission-capable.[27] Furthermore, the COs of the AMS, respond to the WComd and capability advisor group (CAG) and thus have to align their unit's maintenance and repair capability along the wing's priorities, which could differ from flying squadron. This situation is less than ideal as it often creates conflict and disharmony within the Wing Command teams, and sometime to the lowest ranks.[28]

As discussed previously, squadron based maintenance organizations, like SAMEO or flight, are normally able to achieve higher serviceability and availability rate than AMS due the motivation factor.[29] Given the fact that they belong to the same unit as the aircrew and aircraft, maintenance personnel can assess and easily comprehend their actual contributions to operations.[30] This aspect will be further discussed in chapter 4. With these noticeable differences within the RCAF, it is interesting to observe the difference with other structurally similar air forces such as the USAF where drastic alterations in culture were undertaken to improve the overall situation of the organization and its performance

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[26] Ibid. 167

[27] Canada. Royal Canadian Air Force. *Maintenance Policy – Quality Standard for Aerospace Engineering and Maintenance (QSAEM).* C-05-005-P11/AM-001. 2018. 2-9 to 2-15

[28] Based on the author's experience as Deputy SAMEO at 435 Sqn Winnipeg from 2007 to 2009 and as CO of 19 AMS Comox from 2016 to 2018.

[29] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 167

[30] Ibid. 167

USAF

Based on the corporate lessons learned from Toyota motor company and its past experience, the USAF has also embarked in assessing and remodelling specific areas of aircraft maintenance by enhancing cultural changes in order to meet head on the operational requirements of the 21st century. This new initiative is called Air Forces Smart Operation for the 21st century (AFSO21).[31] The required switch in the cultural mindset is commonly called "Red is Good," and it is entrenched in the continuous improvement mentality to improve the empowering characteristics of the maintenance by altering the cultural beliefs and expectations of the organizational structure itself.[32] This approach focussed on the long term desired effects instead the short term effects, which is often not the case in modern air forces. The ability of a maintenance organization or flight to successfully provide sufficient serviceable aircraft in order to achieve the planned daily or weekly flying program (FLYPRO) is usually positively rewarded despite its negative long and medium term effects on the ability to provide unit based training for maintenance personnel.

The lack of patience and flying delays due to aircraft serviceability shortcomings intertwined with the natural RCAF "Can Do" attitude normally do not nurture an environment where mistakes are allowed to thrive in order to promote deeper learning at all level. With this reality in mind, the proposed USAF's transformation comprise of five desired effects: 1) increasing the maintenance productivity, 2) improving readiness and serviceability, 3) increasing responsiveness and agility, 4) sustaining and improving airworthiness and maintenance

[31] McAneny, Paul. *Red Is Good – Transformational Change for US Air Force Maintenance.* Air War College Maxwell Paper No. 46. Air University Press. 1-2

[32] Ibid. 1-2

standards, and 5) improving efficiencies.[33] These five principles are straightforward and can be applied to the continuous improvement foundation of the RCAF maintenance community which is captured by the quality management system (QMS) AF9000+.[34] Traditional "Green is Good" leaders' mindset must be trained and educated in becoming more process oriented aircraft maintainers possessing the willingness and mental fortitude to fully embrace the "Red is Good" approach.[35] In order to be effective, this approach must be assessed by its long term benefits instead of the short term bonus. Trust in the process becomes more important than the actual noticeable results. This is a difficult task to accomplish in the current RCAF's mentality given operational pressures, numerous shortages of qualified personnel, equipment and aircraft and relative smaller size when compared to the USAF.[36] With this in mind maintenance personnel at all ranks must understand that focussing on the long term objectives and accepting delays and mission cancellations will yield an increase in serviceability due to growth in experience in the technician cadre. This analysis is along the lines of system 1 versus system 2 thinking, where a slow and comprehensive thought process trying to adequately frame the problem is able to resolve most issues in a durable manner for all stakeholders.[37] This view is contrary to the natural human tendency in maintenance to promptly leverage on experience, training, and past experience to accomplished objective such as meeting daily flying operations.

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[33] Ibid. 1-2

[34] Canada. Royal Canadian Air Force. *Maintenance Policy – Quality Standard for Aerospace Engineering and Maintenance (QSAEM).* C-05-005-P11/AM-001. 2018. 4-14-1 to 4-14-2

[35] McAneny, Paul. *Red Is Good – Transformational Change for US Air Force Maintenance.* Air War College Maxwell Paper No. 46. Air University Press. 14-15

[36] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 1-3

[37] Honore, Carl. *The Slow Fix – Solve Problems, Work Smarter and Live Better in a world Addicted to Speed*. Alfred A. Knopf Canada. 21-22

In the maintenance community airworthiness is the pillar of all activities. Airworthiness principles and maintenance standards are prescriptive direction that allow limited innovation and reduce the fostering cultural change that could be required for the 21st century. The process of applying repeatable actions with predictable results, while encouraging continuous improvements, highly influences all aspects of the maintenance community. Unapproved deviations of approved manuals such as Canadian Forces Technical Orders (CFTOs) are not acceptable in any situation unless urgent operational requirement is invoked. Therefore, from these core beliefs and essence, the maintenance community is less inclined to leap into innovations and initiatives without thorough and comprehensive reviews and approval process. This reality infused all employment and training areas. The analysis of the USAF transformation states three interesting recommendations that could be seamlessly integrated in the RCAF model. First, the removal of complex processes and non-value added aspects of the works to allow maintenance personnel to focus on their trade and aircraft repair activities.[38] Too often aircraft technicians support Wing or unit activities over a few hours to days that prevent them from performing and developing their primary employment responsibilities: aircraft maintenance.

The second recommendation is to foster a climate where outside-the-box thinking is encouraged in a manner that is aligned with the mentality of "change is good" to improve the community. [39] The encouragement can be stimulated by the annual personnel review system, by recompensing thoughtful forward thinkers, and promoting and highlighting their ideas throughout the institution.[40] The last recommendation is to divert from the current belief that

[38] McAneny, Paul. Red Is Good – Transformational Change for US Air Force Maintenance. Air War College Maxwell Paper No. 46. Air University Press. 17

[39] McAneny, Paul. *Red Is Good – Transformational Change for US Air Force Maintenance.* Air War College Maxwell Paper No. 46. Air University Press. 29

[40] Ibid. 29

maintenance personnel, officers and NCMs, must be more generalists than specialist in a fleet.[41] This recommendation goes against some tenets of the current RCAF approach, especially in the maintenance community, which valorizes a broad breath experience across several fleets in order to develop pan-air forces leaders that understand many stovepipes and can easily manoeuvre the resolution of fleet specific problems and issues.

It would be very difficult to integrate these recommendations in the RCAF. The first and second one are already promoted in certain sections of the maintenance work, where it is recognized that the average time spent by an aircraft technician doing his/her primary job versus spending on non-aircraft related task as discussed at the A4 Maint Council in 2018.[42] The last recommendation is more difficult to implement for medium size air forces such at the RCAF. For an air force the size of the USAF, maintenance personnel can easily grow and fully develop within a single fleet at all ranks. Given their size, even senior leaders, such as general officers, can only affect their own fleets without affecting the rest of the air forces. This is not the case in the smaller RCAF as discussed by Kainikara's view on the world air forces, where any members progressing through the ranks can exert significant influences on other fleets, thus there lays the necessity to promote and facilitate the breadth of experience in a career path.[43] The RCAF and the maintenance community must review its career paths to determine if the current construct favour the style of leaders for the 21st century with forward thinking and inclusive approach to capture all the skills and competences within the air forces.[44]

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[41] Ibid. 29

[42] Based on the author's experience and attendance of A4 Maint Council as CO of 19 AMS Comox from 2016 to 2018.

[43] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 1-3

[44] Based on the author's experience and attendance of A4 Maint Council as CO of 19 AMS Comox from 2016 to 2018.

The USAF also emphasize the primary focus of its organization is its people.[45] They concentrate in recruiting, training, educating, and retaining good personnel, while ensuring there are provided a good quality of life.[46] This attitude is rooted in principle that a collection of members' individual skills and talents will make a difference in a future when knowledge and adaptability will provide an edge in conflict and technological advancement compared to a more rigid enemy force. Therefore, from USAF's perspective, education has to evolve from being inflexible to be more responsive in nature to ensure the competitive advantage remains in their favour.[47] This approach is also embraced by the maintenance community training environment such as CFSATE, where generational and specific learning style are taken in to consideration to optimize the learning experience and associated retention of knowledge. This innovative approach, which has been embraced in several CAF and RCAF learning institutions, uses scenario based learning process, interactive computer enhanced interaction, and gradual on the job training (OJT) opportunity.[48]

The USAF is likewise struggling with similar problem facing the RCAF in the addition of new aircraft fleets such at the Lockheed-Martin F-35 Joint Strike Fighter with no additional maintenance personnel to support.[49] The organization identified a shortage of about 4,000 maintainers in 2016, and thus decided to address the training burden using civilian contractors to train and conduct maintenance activities to foster the development and growth of the military maintenance personnel.[50] This endeavour is expected to take up to 10 years, thus 2026 to ensure

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[45] Nicolls, Bonne. *Airman's Guide – 6th Edition*. Stackpole Books. 2004. 48-49

[46] Ibid. 48-49

[47] Ibid. 48-49

[48] Canada. Royal Canadian Air Force. *Maintenance Policy – Aircraft Weapon Systems Maintenance – Aerospace Engineering and Maintenance Program Managements.* C-05-005-P02/AM-001. 2018. 2-6 to 2-9

[49] Karas, Rachel. Inside the Pentagon's Inside the Air Forces. Inside Washington Publishers. Vol. 28, Issue 46. 2017

[50] Ibid. 2017

sufficient maintenance personnel are available to support USAF mandate.[51] This approach is interesting as it has been used in the RCAF for several fleets where civilian contractors are used at first line units. However, unlike the USAF where the entire institution sets the guidelines and promotes this method to take place, the RCAF's experience has differed by being primarily by fleet's requirements and operational sustainment issues. To be effective the RCAF with this approach, the entire force must actively promote the use of civilian contractors throughout its organization, and properly fund them.[52]

US Air National Guard

Continuing with the review of the maintenance organizations and how they operate, the United States Air National Guard realized the challenges of operations in a complex environment in the twenty-first century, and decided to prepare accordingly by taking drastic steps. This preparation took into account the core principles of the Air National Guard, its "raison d'être," and why it mattered for the future for the future usage of the US air power capability. This exercise was done with the changing tides with respect to the type of conflict being fought by the US and its allies, and with the budgetary constraints experienced by most modern air forces.

The Total Force Integration (TFI) was introduced to ensure the air power readiness and effectiveness in supporting operations such as Noble Eagle, Enduring Freedom and Iraqi Freedom would continue and strive.[53] Moreover, this approach was conducted while considering the boundaries generated by budgetary constraints, reduction in numbers of personnel, force's

[51] Ibid. 2017

[52] Rheaume, Eric. Towards an Equilibrium between RCAF and Contracted Maintenance Following the Procurement of the CF-188 Replacements. JCSP 43 Master of Defence Studies. 2017. 81-85

[53] Dailey, Kevin. Air National Guard Structure for the Twenty-first Century – The Multimission Framework for the Total Force Integration. Air War College Maxwell Paper No.43. 2008. 1

assets recapitalization.[54] The focus was on being able to deliver combined air power effect with direct purposes during these operations. The concept of continuity, corporate knowledge, and esprit de corps was considered a key, if not the key, empowering factor in the ability for the organization to prepare itself for the twenty-first century. The fact guardsmen are not posted and can reside in the location and unit for years is a great advantage and not the reality of the USAF and RCAF with the current policies of progression and development. This concept is similar the RCAF's reserve force.[55]

The Air Guard's approach enables greater feeling of ownership amongst technicians combined with an enhanced maintenance corporate knowledge in the aircraft belonging to the units due to the continuity of their work that can easily span many years and even decades.[56] Many crew chiefs have often seen the aircraft coming off the assembly line and being received at the unit.[57] This situation for the RCAF can be considered exceptional and difficult to achieve unless the technician has transferred to the reserve force. Leadership and taking care of the people was also instrumental in the TFI, by focusing on the operational effectiveness by unit culture, having the right leaders, and addressing administrative obstacles, the foundation was therefore set to promote success throughout the organization.[58] The Air Guard ensured all its supervisors had received human resource training to understand their technicians' minds and desires, and how they can be employed to maximize their output within the Wing's capabilities.[59]

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[54] Ibid. 1

[55] Canada. Royal Canadian Air Force. *Royal Canadian Air Force Reserve*. 2017 http://www.rcaf-arc.forces.gc.ca/en/air-reserve/index.page

[56] Dailey, Kevin. *Air National Guard Structure for the Twenty-first Century – The Multimission Framework for the Total Force Integration*. Air War College Maxwell Paper No.43. 2008. 4-5

[57] Ibid. 4-5

[58] Dailey, Kevin. *Air National Guard Structure for the Twenty-first Century – The Multimission Framework for the Total Force Integration*. Air War College Maxwell Paper No.43. 2008. 28-29

[59] Ibid. 28-29

This method was enhanced by cultivating and encouraging aspects of voluntarism, mobilization and recruiting of personnel.

Although different the RCAF regular forces, clear lessons can be drawn for this example. The Air Guard chain of command took great care in ensuring its personnel understood their value from an organizational level, and how they could improve the feelings of rewards by volunteering and contributing to missions and operations.[60] Leadership was definitely instrumental and further enhanced by having the right people in the right positions; the simple catalyst for the success of the TFI. Many lessons can be drawn based on similarities of the RCAF's maintenance community. The focus on continuity and development in corporate knowledge is at the forefront of the air maintenance community as one of the main limiting factor with respect to Force Generation (FG) and Force Employment (FE). This is the reason why A4 Maint directed all its fleet Senior Air Maintenance Authority (SAMA) during the 2017 A4 Maint Council to review their asset and investigate the possibility of converting around 10% of their workforce into civilian public servants or contractors.[61] This plan was required as all maintenance organizations are struggling with the loss of corporate knowledge due to posting, or early voluntary retirement due to posting. The focus on the organization's needs often trumps the individual needs, to be able to make a lasting difference. The concept of training all supervisors on human resource aspect would be effective in increasing the understanding of the organization with the thought that perhaps more balanced future decision will be taken that will be more sensible to the benefits of the organization and the individual members.

[60] Ibid. 28-29

[61] Based on the author's experience and attendance of A4 Maint Council as CO of 19 AMS Comox from 2016 to 2018.

ROYAL NAVY

Facing similar problems, The Royal Navy (RN) has also decided to review the capabilities of its Fleet Air Arm. With the current budgetary constraints and the nature of the aircraft carrier, difficult choices will have to be made to ensure it capabilities are maintained to expected standards. From their review, the RN (including it air assets) will be expected to do more with less due to the national desire to reduce the defence expenses in this global economy reality.[62] The RN started looking at this in the late 1990s. One example of their vision was with respect to the procurement of the new jet fighter, a fast jet with conventional take-off and land (CTOL) versus short take-off but arrested recovery (STOVL). This was also being considered by assessing the reduction in costs associated with the size of the aircraft carrier required to accommodate the new fighter. This reality is still very much present in many modern air forces struggling with anticipating the acceptable capability gaps in order to meet the budgetary constraints.[63] For the RCAF, the similarities are obvious in many ways the procurement activities are conducted, and often fall prey to the political climate of the moment and lobbying forces acting in many spheres of the senior governance strata of Canadian business and politics.

CONCLUSION

This chapter reviewed the structure and workings of the maintenance community by discussion the genesis of the typical maintenance organizations that are present in the RCAF today. The review started with the restructuration and separation in the early 1990s, which resulted in AMS and flying squadron based maintenance flight; SAMEO. It continued with the standardization of the maintenance community in the 2000s, a successful endeavour led and

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[62] Philips, RTR, Youngs,Alexander. *British Naval Aviation in the 21st Century.* Bailrigg Memorandum. Centre for Defence and International Security Studies. Lancaster University. 1997. 8

[63] Philips, RTR, Youngs,Alexander. *British Naval Aviation in the 21st Century.* Bailrigg Memorandum. Centre for Defence and International Security Studies. Lancaster University. 30-34

monitored by 1 CAD A4 Maint. The chapter also presented the difference success and challenges with respect to the concept of centralized maintenance, AMS, versus decentralized maintenance, SAMEO, and how both concepts yielded great experiences and lessons learned.

Bringing the lessons learned from the USAF, Air National Guard and Royal Navy, it can be seen that all modern air forces have accessed that they must change to meet the operational requirements for the twenty-first century. The changes include a different to look at long term versus short term effect, allowing aircraft technicians to focus on the repair aircraft, fostering outside-the-box or disruptive thinkers, properly training supervisors in human resource, and using civilian contractors promoting corporate knowledge while optimizing training capabilities. All these aspects can be studied and used to render the RCAF's maintenance community a more capable entity for the operational requirement of the twenty-first century.[64]

[64] Reyno, W.C. Less is More: Rethinking the RCAF's Future Rotary Wing Fleet. JCSP 42 Master of Defence Studies. 2016. 69-72

CHAPTER 3: TRAINING AND DEVELOPMENT OF MAINTENANCE PROFESSIONALS

INTRODUCTION

This Chapter will discuss the current method utilized by the RCAF to generate its maintenance professionals and the demands for augmented training and higher for the upcoming century, while taking into account the new technologies, new maintenance philosophy, and lessons learned from air forces and civilian authorities. In order to properly address the challenge in the education of the RCAF maintenance community, it must recognize the deficiencies with the CAF's education programs. From Napoleon's time, it was understood that military leaders should have superior critical thinking abilities to possess the reasoning capabilities allowing them to operate beyond the practices gained from rigorous and repetitive military exercise in order to be able to succeed in battles and campaigns where the unexpected routinely takes place.[65] Hence, providing higher education is essential for the CAF when facing the challenges that will arise in the twenty-first century. Ignoring this aspect cannot be an option, and thus all efforts must be put in place to ensure opportunities are available for all CAF, and including RCAF, members.

EDUCATION IN THE CAF AND RCAF

As noted as early as 1947, DND led by the Minister of National Defence, Mr. B. Claxton, identified officer education as the most important item to address within the Canadian military. Therefore, from this assessments and analysis, it was recommended to establish that a university degree would be a must and requirement for all military officers in Canada, whether through military or civilian universities. This approach would ensure officer candidates would have

[65] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 84-85

greater chance of having superior critical thinking abilities and thus capabilities to adapt with the changing time post-Second World War. Therefore, the military universities were reinvigorated, CMR St-Jean was established, and the curriculum was enhanced to rectify the identified deficiencies in education. In practice, the reality was quite different as the policy came much later into effect in 1997 in the aftermath and recommendation of the Somalia report.[66]

The slow progress was the result of the mentally of the time, which although notionally supported the notion of higher education, did not practically put in place effective enablers in the organization to foster it. Budgetary constraints, varying political ideology of the governments in power, and the presence of a prevalent anti-intellectual sentiment within the Canadian military at the time, which favoured tactical training experience over higher education, all mitigated against the desire for the enhanced education of officers.[67] The Somalia Affair forced this change in culture, driven by the government and public's demands for higher standards within the CAF at all ranks, especially officers. Such intellectual deficiencies are still very much evident as recently as Afghanistan where several officers were returned home due to their inability to think critically.[68] As the world is already dealing with new emergent wicked problems of the twenty-first century, it is crucial that professional military members must have a calm behaviour, adaptive mentality, and possess an openness to enable cognitive capacities to prevail regardless of the rigid military structure and doctrine.[69] With this approach fostered by higher or continuing education, the CAF will be able to promote reasoning ability and flexibility of critical thinking in

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[66] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 12-13

[67] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 16-17

[68] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 12-17

[69] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 82-83

order to successfully overcome unanticipated situation during operations or within the Canadian government structure.[70]

Understanding the essence of the doctrine has become more important that the prescriptive description of said doctrine, as it allows the required flexibility to adapt in order to solve problems. Furthermore, the institution of the Canadian Armed Forces is directed by the mandates and responsibilities imparted upon them by the Canadian government roadmap as defined by the *Strong Secure Engaged – Canada's Defence Policy* released in 2017, and its geo-political reality combined with the vastness of the Canadian territory and sparse population.[71] The RCAF can be considered between a "small to medium size" national air force, depending on the interpretations, that must struggle to balance the needs versus the resources availabilities. Therefore, based on the Canadian defence policy, the RCAF must be able to generate, educate, and develop professional military members to understand the usage of air power and its applications in domestic and international theatres.[72] The same truth applies to maintenance personnel with heightened attention to the flight safety, airworthiness principles, and maintenance standards.[73] With the ideology of maintaining a well-rounded air force, the challenges are significant due to the required generation and sustainment of highly technologically savvy expertise and skills to upkeep and develop the mastery of air power in all facets within available resources.[74]

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[70] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 82-83

[71] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 37-38

[72] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 39

[73] Ibid. 39

[74] Kainikara, Sanu. *The Future Relevance of Smaller Air Forces*. Royal Australian Air Forces. Air Power Development Centre. 2009. 3

Another aspect of the training and education of personnel can be highlighted in the replacement of the CF-188 and the short term solution of purchasing the RAAF used fighters until the competitive process of procurement is completed and a new fleet is received.[75] With this option comes with the fact that the maintenance community is now facing the implementation of a new fleet with all associated action required to respect the airworthiness and maintenance standards. DGAEPM must be ready to absorb another fleet and develop engineering architecture to sustain it and modify to ensure compatibility with the current fighter fleet and its flying practices. Additionally, it must also develop or "Canadianize" the accompanying RAAF technical orders to permit first and second line maintenance personnel of performing their tasks. From the perspective of 1 CAD A4 Maint, who represents first and second line maintenance activities amongst other areas, the new interim fleet highlights the dual conditions of having limited maintenance experience in the fighter fleet in conjunction with being unable to provide adequate level of personnel to support both fleets once fully implemented and at full operational capability (FOC).[76]

Another determining factor in the acquisition and implementation is the trickling loss of maintenance experience and expertise in the fighter fleet. This is a known reality in the fleet and translates into a disproportionate and unhealthy ratio of apprentices to journeymen to NCO affecting the steady growth of technical skills required to sustain the current fighter fleet.[77] The unexpected consequence of the force reduction plan (FRP) in the 1990s with noteworthy demographic gaps in the military populations is also a root cause factor in the lack of experience

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[75] Canada. Government of Canada. *Interim Fighter Capability Project.* 2019 http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1786

[76] Lieutenant-General M.J. Hood, *Fighter Maintenance Renewal Capability Plan – ADM(Mat) Support*, Commander Royal Canadian Air Force. File 3000-2 (A4 Maint). 2017. 2

[77] Ibid. 2

and problematic personnel ratios within the fighter fleets, and in all other fleets.[78] Adding the interim fleet demonstrates the ongoing fragile balancing act by the community and overall precarious states of maintenance personnel. All these aspects are already known and have been tracked by the RCAF and CAF leadership for quite a few years during Air Maintenance symposiums.[79]

To ensure a successful implementation of the interim fighter, 1 CAD A4 Maint has developed a plan with leverages on the contractors and public servant sectors utilizing a hybrid format to maximize the benefits and capabilities for both fighter fleets while minimizing the impact on operations.[80] The plan is comprised of three major guidelines; 1) implementation of a hybrid format between contractor and RCAF technicians to foster greater mentorship and learning opportunities, 2) augmenting the used public servants in first and second line maintenance organization to develop expertise and SMEs with longer tenure than the routine positing cycles, and 3) allowing contractor team, called technical support team (TST) to support first and second line maintenance activities in Canada and on deployments overseas.[81] Using these guidelines, the fighter fleet is expected to be able to generate an additional 202 regular force positions with the plan to redistribute them in the interim fighter SAMEO organization and other CF-188 maintenance organizations within the next five fiscal years (FY).[82] As it can be interpreted, the overarching objective of the approach is to give more capabilities to first line units to increase or least maintain the fighter fleet with no operational impacts during the

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[78] Lieutenant-General M.J. Hood, *Fighter Maintenance Renewal Capability Plan – ADM(Mat) Support*, Commander Royal Canadian Air Force. File 3000-2 (A4 Maint). 2017. 2

[79] Based on the author's experience and attendance of Air Maintenance Symposium as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

[80] Lieutenant-General M.J. Hood, *Fighter Maintenance Renewal Capability Plan – ADM(Mat) Support*, Commander Royal Canadian Air Force. File 3000-2 (A4 Maint). 2017. 2-3

[81] Ibid. 2-3

[82] Ibid. 2-3

implementations of the interim fleet. This approach is very similar in essence with the USAF's plan for the introduction of the F-35 Joint Strike Fighter, where the organization decided to use contractor to address an estimated shortfall of 4,000 maintenance personnel to properly fill the new fleet's requirements.[83] The USAF expects the maintenance personnel gap to be closed within 10 years.[84]

With this RCAF Commander's direction, all fleets, through their respective SAMAs were mandated to generate a potential hybrid plan starting with at least 10 percent of public servants.[85] All RCAF maintenance organizations were reviewed internally with a focus on what sections could be transitioned into a hybrid workforce with public servants and military to the extent of being completely (i.e., 100 percent) staffed by public servants. Each SAMA or CO of AMS presented their fleet plan to the 1 CAD A4 Maint council in fall 2017, points were discussed, and lessons were learned as some of the AMS and squadron based maintenance organizations already had public servant or were in the hiring process.[86] Whether or not this initiative materialized, the ideology and lessons learned from the discussions were sufficient to have all AMS review and evaluate their allocation of positions to determine where public servants, and in some cases contractors, could be employed to maintain the experience, SME's corporate knowledge, and training capabilities for a longer period than the usual posting cycle.

Taking into consideration the identified shortfalls, can the question of whether or not the current RCAF's maintenance community construct effectively promote critical thinking within

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[83] Karas, Rachel. Inside the Pentagon's Inside the Air Forces. Inside Washington Publishers. Vol. 28, Issue 46. 2017

[84] Ibid. 2017

[85] Based on the author's experience and attendance of A4 Maint Council as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

[86] Based on the author's experience and attendance of A4 Maint Council as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

its officers and NCNs cadre with such lack of personnel is a valid one. The genesis of the problem is rooted with the Canadian military unification in 1968.

As a result of the 1964 White Paper, on 1 February 1968, the RCAF, Royal Canadian Navy (RCN) and Canadian Army were disestablished and merged into the Canadian Armed Forces and the former assets of the RCAF (now referred to as the "air element") and its personnel were dispersed amongst the various CAF commands. Concerned about the efficient prosecution of air power in Canada, a number of air element senior officers led by Lieutenant-General William "Bill" Carr, successfully advocated for greater air power centralization. With the resulting establishment of Air Command in 1975, all air assets, including those of the former RCN and Canadian Army, were centralized in Canada.[87]

With this centralized approach throughout the institution, including the educational curriculum, all aircraft maintenance personnel in the CAF were now members of the RCAF and were therefore trained by the same instructional schools. This centralized aspect greatly favoured group thinking throughout the maintenance community and did not foster a true climate of critical thinking that could benefits specific fleets in enabling the RCAF for the twentieth century and the twenty-first century. Although the benefits of this centralization endeavour cannot be discounted by its ability to maintain the same high level of airworthiness and maintenance principles throughout all CAF air assets, it still does come at a cost of limited generation of outside-the-box and disruptive thinkers.[88] In 2011, the RCAF was restored and returned to its

[87] Goette, Richard. *Canadian Armed Forces Unification and Canadian Air Power*. *Airforce* magazine, Volume 42, Number 3 (2018): 16-23;

[88] Based on the author's experience at 1 CAD A4 Maint Transport SAR section from 2011 to 2012.

historical roots.[89] The current centralized bureaucratic structure enables the CAF and the RCAF to be able to aim the organization towards solutions with the greater benefits for the greater number; however it fails to capture and address niche capabilities or demands due to budgetary and resources limitations. This reality is similar with the USAF and other air forces that are competing for similar air assets with their own land and naval counterparts.[90]

AERE

As the AERE trade generates all aircraft maintenance officers in the RCAF, it is essential to ensure there are adequately equipped from a leadership, management and technical perspectives to face the maintenance required of the twenty-first century. The challenges of Professional Military Education (PME) for the RCAF officers have been identified and target at least since the late 1990s. Shortcomings combined with the inability to comprehend the complete utilization of air power was an issued that the RCAF has tried to address through several initiatives including the creation of a RCAF Aerospace Warfare Centre (RAWC). The intent behind the promotion of the PME for officer was to develop strong analytical and communication skills, understanding of the complexity of operating environments, intellectual flexibility, and competencies in the utilization of air power.[91] This requirement is based on the established requirements that the RCAF must encourage the generation and maintenance of a strong and competent intellectual capital base by fostering airpower mindedness, critical thinking

[89] Canada. Royal Canadian Air Force. *RCAF celebrates 92 years of service*. 2018. http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=rcaf-celebrates-92-years-of-service/i7ynw2hu

[90] Hasik, *James. Mimetic and normative isomorphic in the establishment and maintenance of independence air forces*. Defence & Security Analysis. 2016. 261-262

[91] Beauregard, Andre, Hanson, Jim. *Air Power at the Turn of the Millennium.* Canadian Institute of Strategic Studies. 1999. 66-68

and augmented analytical skills.[92] This ideology combined with the recognized understanding that all officers should possess decisive leadership qualities by encompassing the reflection of the values and diversity of its members, the stewardship of the resources, and continuous improvement via education to face the challenge of the twenty-first century.[93]

It is one of the widely held beliefs that the wars and conflicts of this century will be conducted and won by brain-on-brain warfare.[94] The requirements for the specialized nature of the military professional was clearly identified in 1969 by the officer development board (ODB) which stated the officer professional development (OPD) should abide by the following; 1) the comprehensive understanding and devotion of all officers in the service philosophical and ethical demands expected of them, 2) a mastering level of the sphere of expertise, 3) and the belief that all should be awarded the opportunity to develop their intellectual potential.[95] For the AEREs the intent is clear; a better understanding of the operations combined with a mastery of the maintenance models are essential to ensure the maintenance personnel realize their contribution in the CAF's operations. With this aspect in mind, AERE officers must undergo professional military training to enhance the required skills to navigate and influence the RCAF operational concepts. The requirements to ensure maintenance personnel understand and comprehend the air power mastery are paramount to adequately enable operations.[96] Without this understanding

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[92] Gladman, Dr. Brad, Dr. Richard Goette, Dr. Richard Mayne, Colonel Shayne Elder, Colonel Kelvin Truss, Lieutenant-Colonel Pux Barnes, and Major Bill March. *"Professional Airpower Mastery and the Royal Canadian Air Force: Rethinking Airpower Education and Professional Development*." Royal Canadian Air Force Journal 5, no. 1 (Winter 2016). 2016. 8-15

[93] Beauregard, Andre, Hanson, Jim. *Air Power at the Turn of the Millennium.* Canadian Institute of Strategic Studies. 1999. 14-15

[94] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 82.

[95] Horn, Bernd and Bentley, Bill. *Forced to Change – Crisis and Reform in the Canadian Armed Forces*. Dundurn Toronto. 2015. 13

[96] Gladman, Dr. Brad, Dr. Richard Goette, Dr. Richard Mayne, Colonel Shayne Elder, Colonel Kelvin Truss, Lieutenant-Colonel Pux Barnes, and Major Bill March. *"Professional Airpower Mastery and the Royal*

issues observed in the past with respect to motivation and serviceability rate have a greater change of reoccurring. 1 CAD A4 Maint, the RAWC and also 2 CAD with CFSATE are essential stakeholders in defining the guidelines and directions that must be taken to properly aim toward the development of AERE officers well equipped to face the maintenance concepts of the twenty-first century. The same applies to maintenance technicians and their understanding of what roles they play in the operation capability due to their level of experience and associated impact. This study will review the USN case study to further explore this aspect.

USN

The United States Navy (USN) has decided to look at the relevant of naval aircraft maintenance technician experience with respect to aircraft production and serviceability. The organization realized that aircraft readiness is proportionally related to the level of experience aircrew and technicians present in the unit.[97] The USN reviewed the development of its aircraft technicians from their first posting to achieving the senior ranks of non-commissioned officers in order to properly determine the positive and negative factors that could affect the required growth and learning in the area of maintenance. It also evaluated the impact of posting cycles and how selection of personnel being posted to certain unit mattered. The USN considered two metrics with respect to career planning and posting cycles; fitness and people (numbers). There lies the root of the problem and how to solve it. From the situation's analysis, it was determined that the main factor of success for the long term was the experience of the technician on a specific aircraft. Therefore, the career management organization added the factor of experience

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Canadian Air Force: Rethinking Airpower Education and Professional Development." Royal Canadian Air Force Journal 5, no. 1 (Winter 2016). 2016. 8-15

[97] Ventimiglia, Matthew. Experienced Technicians Matter. United States Institute. Annapolis Vol. 142, Issue 9. 2016. 80-82

and how recent it was to determining the next posting for a specific member.[98] This method allows the proper evolution of the file and how best uses the critical experience of a specific aircraft type with the overall organization while taking into account the member's individual personal and professional career paths. Then the evaluation assessed the posting cycle with specific attention to the length of tour by comparing posting in United State, usually four to five years, versus those out of country, usually two to three years.[99]

From this assessment it was discovered that the longer postings in United States were more beneficial to the experience of the technicians. This experience could significantly affect a unit's production rate and its ability to effectively train from within. From this complete examination, it was decided to modify to the career management process to include the experience of technicians, attempt to keep technician on the same fleet until achieving senior non-commission officer ranks, plan for training technicians with the primary objective of becoming a technical instructor, and extend the length of positing for officers and non-commissioned members to the same location and ideally the same unit or fleet. These initiatives have the goals of improving the experience on the aircraft type and overall corporate knowledge, while encouraging aircraft ownership through the members.[100] The discussed USN's review and proposed solutions are similar to the RCAF's perspective with respect to the maintenance community; which is encouraging and positive. Both organizations share the intent of increasing the length of the posting cycle, keeping personnel on the same fleet, and intent in placing experience technicians with the required maintenance organization.

[98] Ibid 80-82
[99] Ibid. 80-82
[100] Ibid. 80-82

The marked differences between the USN and the RCAF are in the documenting of the experience and how it plays with the career management of maintenance personnel, the rank to which technicians are expected to remain in the fleets, and geographical stability. In the RCAF, the documentation of the experience is only superficially captured by the member personal record resume (MPRR) but it requires validation usually done by direct communication with the members themselves and their chain of command. Given the small size of the RCAF, this process yields acceptable to good results but it allows an unwanted level of suggestibility by all the stakeholders. A quantitative method would be preferred with limited reliance on communications between stakeholders. With this method, experience would be quantifiable and thus could be more considered during posting cycles. It would not be at the mercy of how well the member is known within the RCAF community, or how diligent the Career Manager (CM) carried his/her task, but institutionalizing it would provide greater transparency in the posting process and thus improve its understanding and trust from the maintenance personnel.

The rank difference between the RCAF and USN in which technicians should remain on the same fleet is also another interesting factor to consider. In the RCAF the goal is to keep technicians within the same fleet until they are promoted to WO, which is equivalent to E6 promoted to E7, the USN wants to maintain members focused on a specific fleet until the rank of E9 promoted to W1. This would be the equivalent from a RCAF's perspective of having Master Warrant Officers (MWO), and Chief Warrant Officers (CWO) still technically involved in the production and readying of an aircraft. This would be difficult to accomplish within the RCAF's capabilities but it is an interesting aspect that is worth exploring in the future. Along the same lines, could a member at the rank of CWO decide to not be employed within leadership and command roles but rather in the realm of experienced technical expertise within maintenance

organization?[101] Before the recent decentralization exercise of the AMS, this was the reality at a certain extent. Units such as 8 AMS had a single CWO who was part of the command team, and several CWOs within its flights. The positions were removed and reallocated to other more senior roles. Furthermore, there is currently a rationalization process that is taking plan across the CAF which should make the ranks more scarce in other organizations of the maintenance community such as ADM (Mat) and 1 CAD A4 Maint.[102] Another difference worth discussing is the fact that geographical stability and retention does not come into consideration in the USN's assessment to improve technical experience and corporate knowledge. This is definitely not the case in Canada, where it is one of the essential cornerstone of the reason why retention is some of the most critical and essential facets in keeping the workforces, and preventing retention problems.[103] This difference lies potentially in the fact the USN might not be experiencing the same level of difficulties in recruiting qualified personnel to join its organization unlike the CAF.

US ARMY AVIATION

An interesting example to also consider is the United States Army Aviation realization that the poor state of its aircraft fleets after nearly two decades of significant operations on the global war on terror in numerous theatres in the world.[104] Stress on the aircraft and fast pace of operations for maintenance personnel led to the morphing of the technicians into "box" removers and installers instead of adept troubleshooting maintenance professionals.[105] Troubleshooting skills are an essential expertise that is acquired through maintenance experience gained by years

[101] El-Beltagy, Vivian. *The CAF's Greatest Challenge: Retention Culture*. JCSP 44 Masters of Defence Studies. 2018. 54-56

[102] Based on the author's experience as Deputy SAMEO at 435 Sqn Winnipeg from 2007 to 2009 and as CO of 19 AMS Comox from 2016 to 2018.

[103] El-Beltagy, Vivian. *The CAF's Greatest Challenge: Retention Culture*. JCSP 44 Masters of Defence Studies. 2018. 54-56

[104] Chandler, Jerome. *Army Aviation Maintenance Takes On Training, Logistical Challenges.* Aircraft Maintenance Technology. January/February 2018. 2018. 27

[105] Ibid. 27-28

of working on certain type of aircraft, experiencing numerous possible unserviceability defects, and successfully finding ways to repair the defects themselves. The impacts resulting from the lack of such knowledge have increased maintenance cost and lower serviceability for the aircraft.[106]

As described in Jerome Chandler's article in *Aircraft Maintenance Technology*, many expensive components, such as engines, were routinely removed from aircraft at first line organizations due to the fact that they were deemed unserviceable by technicians that did not possess sufficient troubleshooting skills, and serviceable components installed immediately afterwards. The removed components were shipped to depot level maintenance, tested by more experienced technicians, and found to be serviceable with minor adjustments or sub-component replacement. Given this reality and impact on operations and associated financial implication, the US Army Aviation decided to act on the identified concerns and strive towards enhancing the level of corporate knowledge and expertise of its technicians and maintenance personnel by aiming to develop holistic professionals possessing abilities to effectively troubleshoot serviceability defects. They elaborated a direct approach that focussed on inculcating in apprentices and junior technicians with the foundation of how component operate within the aircraft's airworthiness and mission specific capabilities.[107]

A deeper and comprehensive understanding of how the aircraft and all its systems operate is essential in the development of technicians. The practical application of these shifts was to begin with the change of mentality starting with the usage of virtual reality tools to improve the technician's knowledge and familiarity with specific components and characteristics associated

[106] Chandler, Jerome. *Army Aviation Maintenance Takes On Training, Logistical Challenges.* Aircraft Maintenance Technology. January/February 2018. 2018. 27-28

[107] Ibid. 27-28

with specific aircraft type.[108] From the RCAF's perspective when it comes to training apprentices and junior technician, this method is perfectly aligned with three key features of the twenty-first century reality; 1) reducing the impact on components, 2) reducing overall cost, and 3) effectively using modern technology to teach. Virtual reality is currently used as training aid at CFSATE in CFB Borden and at fleet maintenance training schools such 406 Maritime Operational Training Squadron in Shearwater, and 426 Transport Training Sqn in Trenton.[109] The reduction of the wear and tear on the components associated with the removal and reinstallations is a known factor that is tracked via maintenance practices of defining the component as a training aid, and categorizing it accordingly.[110]

The overall organizational cost reduction is another important factor due to the fact that effective training can be delivered without removing a serviceable component or grounding a mission-capable aircraft destined for operations. Lastly, the most significant factor is the fact the delivery means for the training is a medium that is, and will become more familiar with the new apprentices and junior technicians as they will emanate from the millennial and Gen Z generations. These junior members are already familiar with virtual reality, and with younger member joining the RCAF, this approach has to become a more prevalent method of delivering instruction in the future.[111]

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[108] Chandler, Jerome. *Army Aviation Maintenance Takes On Training, Logistical Challenges.* Aircraft Maintenance Technology. January/February 2018. 2018. 30

[109] Connock, Sonia. Royal Canadian Air Force - Embracing the future: RCAF finds solutions in innovative training technologies. 2014 http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=embracing-the-future-rcaf-finds-solutions-in-innovative-training-technologies/ht8s3wor

[110] Canada. National Defence. *Maintenance Policy – Aircraft Weapon Systems Maintenance – Aerospace Engineering and Maintenance Program Managements.* C-05-005-P09/AM-001. 2018. 4-1 to 4-3

[111] Pearson. Beyond Millennials: The Next Generation of Learners. Global Research & Insights. 2018. https://webcache.googleusercontent.com/search?q=cache:vg6FvSUohY0J:https://www.pearson.com/content/dam/one-dot-com/one-dot-com/global/Files/news/news-annoucements/2018/The-Next-Generation-of-Learners_final.pdf+&cd=18&hl=en&ct=clnk&gl=ca

The US Army Aviation also focused on the overall understanding of their forces, military and civilian capabilities, with respect to the planning and preparation before major scheduled inspections. They drew information from data to determine which components had the higher percentage of failure, ordered it in advance, and prepared the required support means in order to carry these maintenance replacement tasks. The inspection time was reduced significantly, as discussed in certain cases from 500 days of inspections for the average tactical helicopters to 350 days; a reduction of 30 percent.[112] This approach to scheduled inspections as depot levels is aligned with civilian industry standards, and can definitely enable greater serviceability and improved availability for military air forces. Less time dedicated for the inspection results in more availability for operations, hence adequately distributing the flying hours across the fleet. It is an interesting fact that the US Army aviation is aligned with the RCAF model of training on troubleshooting and development of a more comprehensive understanding of the whole aircraft, the systems and how they all operate with each other.[113]

VIRTUAL REALITY

As discussed with the US Army Aviation case, technology will change the ways many industries train and qualify their maintenance personnel. Furthermore, by tracking the lifecycle of the aircraft, virtual reality (VR) is become an effective tool to exploit and use in the future. The naval environment faces similar technical challenge that can be compared to the aviation environment with respect to seaworthiness and airworthiness. Both maintenance of these aircraft require great technical knowledge and expertise that can often only be grown within the organization. Additionally, all military forces, whether land, air and naval elements, constantly

[112] Chandler, Jerome. *Army Aviation Maintenance Takes On Training, Logistical Challenges.* Aircraft Maintenance Technology. January/February 2018. 2018. 32-34

[113] Based on the author's experience as AEO and SDEO of CC130 E&H from 2014 to 2016 and as Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

seek options to deliver effective training to maintenance technicians, while optimizing the training deliver means by potentially not using operational platforms. The goal is to not impact operations by not reducing the aircraft availability. With this fact, virtual reality provides a means by which technicians can develop and hone their skills to achieve training objectives in a safe, secure and cost effective environment with limited operational impacts, if any.[114]

Furthermore, virtual reality can be used at first line units, such at Sqn or AMS, by many simultaneous users to foster a team learning environment using their avatars.[115] Each user can see the other users' avatars and thus can assemble and dissemble components and systems, while interacting and watching each other. This technology can also be used to improve the troubleshooting abilities by allowing faster research abilities throughout the technical manuals by providing a platform where such activities can be carried out remotely from the main operation base (MOB) or away from the aircraft with minimum time searching through the publications.[116]

The naval forces are also investigating the potential of 3D printing as it would be an undeniable enabler with respect to the logistical and supply stressors in remote areas, requirement for storage space for spares parts, and operational responsiveness. Lockheed Martin is planning to combine the virtual reality enabling capabilities with 3D printing to shift the maintenance philosophies from the traditional reactive and preventive maintenance concepts into a more predictive maintenance philosophy. This new way of viewing maintenance will leverage on digital technologies and by focussing on knowing in real-time the status of a platform such as ship or aircraft instead of discovering it during operations or maintenance inspections. Furthermore, predictive maintenance will aim from a long term perspective to provide a

[114] Valenti, Alex. *Back to the Future – Virtual Maintenance Tools*. Surface & Sub-Surface. Naval Forces I/2019. 2019. 20-22

[115] Ibid. 20-22

[116] Ibid. 20-22

collaborative approach using medium such as open cloud environment empowering maintenance personnel to make educated decisions in real-time throughout the entire lifecycle of the platform.[117]

These modern and digital technologies can undoubtedly be used by the maintenance community in order to enable the RCAF's concept of operations. VR implementation from the ab initio training to the troubleshooting maintenance problems experienced from depot level to first level operational environment can positively enhance the effectiveness of maintenance activities and foster a learning environment. CFSATE is already using computer based scenario in where players and students can navigate a maintenance and supply world to better understand what is expected of them once the training period is completed. VR would improve the process and provide an excellent tool at all level of maintenance, especially when several members can simultaneously partake in the training experience or troubleshooting activity. 3D printing is already being researched for the RCAF, as it would allow less spares to be stored, and provide quick access to parts in remove location, such as overseas deployments, with limited impact or delay to operations. The only time required to produce the part or component would be a combination of researching the part in publication and actually printing it. Furthermore, this aspect would reduce the cost associated with storage and logistic delivery means, reducing the logistic budget for the RCAF and CAF. [118]

The shift in maintenance philosophy is already embraced by the newer aircraft such as CC-177 Globemaster and CC-130J Hercules, where constant communication between the aircraft, its operating systems, and the ground via satellite means, can provide real-time

[117] Valenti, Alex. *Back to the Future – Virtual Maintenance Tools*. Surface & Sub-Surface. Naval Forces I/2019. 2019. 22-24

[118] Based on the author's experience in the A4 Maint Transport SAR section from 2011 to 2012 and as Council as CO of 19 AMS Comox from 2016 to 2018.

information on the aircraft serviceability.[119] The challenge is that often maintenance decisions are taken only once the aircraft has landed and the troubleshooting activities have taken place. With real-time decision being taken, the parts could already be order, and maybe received in the hand of the maintenance team receiving the aircraft landing. They would have already performed the maintenance repair as a team using the VR, and thus would be ready to perform the exact maintenance task on the aircraft, thus minimizing the downtime, optimizing the logistical lime, and maximizing the learning opportunities as several apprentices could be VR and real life witness to these actions. This is truly a game changer in the maintenance world.

CONTINUING ARWORTHINESS

As airworthiness is the bedrock of the crash cases of Aloha Airlines B737-200 in 1988 and RAF Nimrod XV230 in Afghanistan in 2006 are of particular interest as they highlight events where continuing airworthiness played a crucial role especially in the realm of aging aircraft, how they were maintained and what is the life expectancy that can be expected of them. Both case highlight the difficult reality of analyzing and determining through engineering calculations, life cycle management, fatigue, and flight hours the status of the aircraft and most importantly what how they can be used for the foreseeable future without impeding their airworthiness.[120] Moreover, both cases underlined deficiencies in the tracking and monitoring of fatigue cracking, stress tracking on the airframe, maintenance factors, and airworthiness and certification issues with the aircraft themselves.[121] They demonstrated problem with abiding to continuous principles for civilian and military aviation institutions.

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[119] Based on the author's experience in the A4 Maint Transport SAR section from 2011 to 2012.

[120] Le, Huong and Lappas, Ilias. *Continuing Airworthiness: Major Drivers and Challenges in Civil and Military Aviation.* Vilnius Gediminas Technical University (VGTU) Press. 2015. 166-167

[121] Ibid. 166-167

The root cause of this issue lies in the education and training of maintenance personnel that did not take into account the structure of aging aircraft in the previous decades before these crashes. To properly understand why this was not such a problem in the decades before was based on how aircraft were built and what was their life expectancy. For example, in 1981 for the civilian aviation, aircraft were designed and built with the average life expectancy of 15 years or 50,000 flight hours, and in contrast to 1991, where the same stats were 20 years and 60,000 flight hours. Furthermore, the situation is exacerbated by currently having many passenger aircraft designed for such purpose modified in the later part of their lives into cargo aircraft, which tremendously affects the structural integrity and thus require greater airworthiness monitoring to ensure the safety of flight.[122]

The challenge is comparable with the military aviation with a slight difference when it comes to regulation, which is the fact that in numerous countries, including Canada, air forces have their own national air regulation allowing them to operate aircraft in their country with no direct oversight or abidance of civilian regulations.[123] In most cases civilian regulations and recommendations are followed but they do not have to be in many situations, like the CAF and Transport Canada under the Canadian Aeronautical Act.[124] Therefore, many air forces and defence forces are the owner, operator, maintainer, regulator, and designer of engineering modifications on their own national aircraft.[125]

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[122] Ibid. 166-167

[123] Le, Huong and Lappas, Ilias. *Continuing Airworthiness: Major Drivers and Challenges in Civil and Military Aviation.* Vilnius Gediminas Technical University (VGTU) Press. 2015. 169

[124] Canada. National Defence. *Technical Airworthiness Manual (TAM).* C-05-005-001/AG-001. 2015. 1-1-1-1

[125] Le, Huong and Lappas, Ilias. *Continuing Airworthiness: Major Drivers and Challenges in Civil and Military Aviation.* Vilnius Gediminas Technical University (VGTU) Press. 2015. 169-170

As current aircraft age and stay in usage longer than expected, it has become a reality to ensure civilian and military aviation institutions embrace new methodology to ensure the continuation of airworthiness and safety of flight the authors of the *Continuing Airworthiness: Major Drivers and Challenges in Civil and Military Aviation* proposed the Lewin's change management model to meet the airworthiness requirements of the twenty-first century.[126] This model is based on three large category of a flow chart; first, the process of "unfreeze," where mentalities have to be accepting and ready to grip change. Secondly is the "change" part, where new attitudes are developed with robust action planning, stabilization, and possible consequences. And finally, the third part of the process is called "refreeze" where consolidation of new changes is accomplished in conjunction with enabling mechanism, policies, and structures, while assessing the effects of the consequences through a monitoring method and feedback loop. The authors argue that the civilian and military have to be ready to change, in light of the stated air accidents, in order to be prepared to face the challenges of aging aircraft and their associated problems.[127] This approach is disruptive in nature but cannot be overlooked for the requirements of the twenty-first century. The RCAF has a tradition of effective monitoring and management off aircraft fatigue and structural stress due to the fact that many fleets assume many operational roles and are kept in operations longer than the original life span. This is highlighted by the technical airworthiness manual (TAM) under the policy for aging aircraft.[128] For these reasons, adopting such mentality would yield profound changes based on acquired experience to face the new unexpected challenges.

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[126] Ibid. 169-170

[127] Ibid. 169-170

[128] Canada. National Defence. *Technical Airworthiness Manual (TAM).* C-05-005-001/AG-001. 2015. 3-4-2A-3 to 3-4-2A-6

AFGHANISTAN AIR FORCES EXPERIENCE

Keeping in line with experiences and lessons learned to development maintenance professionals, the case of the USAF lessons learned emanating from the teaching and training Afghanistan Air Forces (AAF) maintenance personnel can definitely be used as an example to stimulate the students to learn using their independent judgment and own mistakes.[129] As descried in the article referenced, one of the most thought-provoking teaching aspect from the advisors' perspective was to allow the students to make mistakes, and be given ample time to troubleshoot the root causes of these mistakes with the belief of repairing the deficiencies. USAF and coalition advisors had to learn to be patient with the AAF maintenance personnel, and restrain themselves from the "I will do it myself" attitude if the students were taking longer than expected to rectify a deficiency. Although the serviceability was slow to improve due the significant learning curve, in due course it began to noticeably increase. This approach encouraged self-reliance by empowering the students to make mistakes and resolve the issues without depending on the support of the advisors.[130] It empowered them and promoted ownership of the tasks performed; which is an excellent trait to develop in any RCAF professional. Using this ideological model, RCAF leadership has to put the time and effort into encouraging the same trait and performance with the maintenance community. Missions will be delayed or cancelled but the long term objectives of establishing a foundation where growth in expertise is actively stimulated will be achieved. Trust the process is more important and will yield durable result instead of the quick-fix mentality.

[129] Douglas, Matthew and Ritschel, Jonathan. *Air Advising in Afghanistan*. Air & Space Power Journal. 2018. 87-88

[130] Ibid. 87-88

AUSTRALIA

As part of this research study, the Australian models demonstrated interesting approach in developing the civilian maintenance industry by changing the core training foundation to meet the perceived demands of the coming years. This research study looked at the recent licensing and training reform in the Australian aircraft maintenance industry with interest as a way to properly frame the problem and address training issues. This perspective can be expanded to the RCAF's maintenance community as it related to promotion rhythm, and how much experience is gained by aircraft technicians by the time they reach the ranks of Sergeants or Warrant Officers.

Before the Australian reform, aircraft maintenance technicians underwent a traditional or classic apprentice training based on theoretical and practical on-job-training regulated by the Civil Aviation Safety Authority (CASA).[131] The traditional training burden was shared between technical educational institution and employer throughout the developmental phases.[132] However, in an effort to augment the national output of maintenance technicians along with the intent of standardizing the maintenance qualification and certification to recognized international standards, CASA introduced new sweeping regulations to solve the issues. Hence, Australia aligned itself with the qualification and licensing regulation of the European Aviation Safety Agency (EASA) to achieve its long term national maintenance objective of self-reliant workforce, to make the country's maintenance industry more attractive to the needs of the international airlines seeking to have maintenance activities carried out in Australia, and to provide greater international mobility to its maintenance personnel.[133] The reform introduced

[131] Hampson, Ian and Fraser, Doug. *Licencing and training reform in the Australian aircraft maintenance industry*. Journal of Vocational Education & Training. 2016. 342-344

[132] Ibid. 342-344

[133] Hampson, Ian and Fraser, Doug. *Licencing and training reform in the Australian aircraft maintenance industry*. Journal of Vocational Education & Training. 2016. 342

was competence-based training (CBT) with the goal of providing objectives, valid and reliable assessment processes of training outcome based on the administration of three primary stakeholders; the businesses employing the apprentices, the institutions enabling the training to take place, and the regulatory authority monitoring and approving the training.[134] All three stakeholders played a vital role in ensuring trained, qualified, and authorized maintenance technicians possessed the skills and knowledge to meet the airworthiness requirements and maintenance standards expected by industry.

In addition, the CBT did not grant qualification based on a pre-determined time basis unlike the principle of the previous system, but it did based on demonstrating competence in performing the task. This is considered a deliberate shift from the previous traditional training process. Combined with strong incentives by the funding model to generate more trainees, the process was viewed as displaying potential conflict of interest as businesses could be swayed in approving or stove-piping their apprentices to meet their needs more than the developmental requirements in conjunction with interesting financial aspects. In additional CASA's responsibilities as the regulatory authority slowly transitioned itself into a more formal procedural invigilator by delegating numerous administration responsibilities with respects on the examination process and actual questions being asked. CASA did not possess a databank of questions like under the previous process but it did review the process through regular industry audits. The conditions set the ground for the issues to emanate from and with time doubts started

[134] Hampson, Ian and Fraser, Doug. *Licencing and training reform in the Australian aircraft maintenance industry*. Journal of Vocational Education & Training. 2016. 345-346

to arise for the technician cadres since accredited employers were able to set their own standards to meet their own demands instead of the industry itself.[135]

The reform did not yield the expected results. The standards achieved were not to the level expected to translate into the attractive workforces for the Australian maintenance industry and its desire to compete on the international arena. It did not provide the training means in which apprentices could grow and mature into competent technicians capable to conducting maintenance and repair activities within their area of certification. Moreover, it failed to generate sufficient technicians to accommodate the rising demands for a qualified and capable workforce. It was acknowledged by interviews during the regulatory audits conducted by CASA that the level of competence generated by the CBT was concerning and did not meet the accepted standards, which was not the situation under the previous training system. This reality led to the reform being revised with the expectation that the new process could leverage on the lessons learned from the previous training process while embracing the guiding principles and essence of the new reform to meet the defined national objectives.[136]

The Australian experience is truly relevant for the RCAF as it showcases secondary and tertiary effects of reforms being observed years after their initial implementations. This situation highlighted the difficulties of properly framing the problem to address select proper solutions while comprehensively considering all factors that have the possibility of influencing the outcomes and results. The RCAF in recent years has undergone significant changes and alterations in its training establishment form the restructuration of eleven trades into three in early 1990s, and Air Occupation Enhancement (AOE) initiative which include reforming the

[135] Hampson, Ian and Fraser, Doug. *Licencing and training reform in the Australian aircraft maintenance industry*. Journal of Vocational Education & Training. 2016. 346-349

[136] Hampson, Ian and Fraser, Doug. *Licencing and training reform in the Australian aircraft maintenance industry*. Journal of Vocational Education & Training. 2016. 347-349

work of air weapons technician (AWS) and aircraft structure technicians (ACS).[137] These changes have been significant in nature with a surprising fast pace that it is hard to fully comprehend the complete amendments unless a person is fully immersed in the program sphere due to many ramifications and phase approach.[138]

These numerous changes generate some level of frustrations within the maintenance community and associated trades such as pilots and air combat system officers, as many do not completely understand all the required alterations to meet the objectives. The problem is often exacerbated as the posting cycle brings new personnel in key roles with no to limited background knowledge and understanding of the initial intent of the endeavour. By not understanding the genesis of the program it becomes difficult to comprehend the path chosen by previous stakeholders; and thus there lie some of the issues and related frustrations by many in senior roles.[139]

The RCAF maintenance community should try to curtail the pace of the changes, amendments and alterations to its training and developmental program in order to allow the maturing and thorough exploitation of the recent ones. This approach will allow all possible and safe consequences to occurs in the secondary and tertiary effect realms, identify airworthiness concerns, and rectify the problems in a collaborative manner to ensure the greater success for the long term. Omitting adequate the time for problem to manifest itself and changing the vision rapidly will only result in the vicious cycle of trying to solve the current problem. Therefore,

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[137] Based on the author's experience as Deputy SAMEO at 435 Sqn Winnipeg from 2007 to 2009 and as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

[138] Based on the author's experience as Deputy SAMEO at 435 Sqn Winnipeg from 2007 to 2009 and as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

[139] Ibid.

without the system 2 approach, the organization is bound to repeat the same mistake as corporate knowledge usually last a few posting cycle.[140]

CONCLUSION

This chapter covered the aspect of the RCAF required to train and develop maintenance professionals capable of using critical thinking combined with the available and future technologies to meet the demand of the twenty-first century. This approach must originate from fostering an environment favourable for higher education and using outside the box ideas to position the organization for meeting operations in the future. Furthermore, as part of this renewal, the importance of the roles of the maintenance officers, AERE, must be emphasized as they are considered the strategic link between understanding the operational need and the mastery of maintenance requirements such as airworthiness and maintenance standards.

A review of the assessments and initiatives from the USAF, USN, and US Army Aviation demonstrated similarities with the RCAF's reality and provided lessons learned that could be emulated with a Canadian flavour. All three forces address the shortage of personnel, lack of suitable career planning benefiting the organization and members, and the deficiency with the development of troubleshooting skills versus the box remover and installer mentality. With these issues in mind, virtual reality will definitely play a crucial role in the coming years in the training of troubleshooting skills and major shift in maintenance from a traditional reactive and preventive maintenance approach to predictive methodology. This change of mentality will be enhanced by the rising airworthiness strategic to manage fatigue and structural stress of aging

[140] Honore, Carl. *The Slow Fix – Solve Problems, Work Smarter and Live Better in a world Addicted to Speed*. Alfred A. Knopf Canada. 2013. 21-22

aircraft that will require a further move in attitude towards effective policies and regulation to effectively ensure the safety of flight.

The development of maintenance professionals must stay the focused of the RCAF and it can leverage of the experience of the Afghanistan Air Forces where advisors realized that allowing independent judgment and mistakes to occur foster growth and confidence in technicians that will provide durable benefit is the long run. Along the same lines, the Australian experience with its civilian aircraft technician reform showcased interesting lessons learned that could be studied by the RCAF maintenance community. Often overlooked are the potential and unforeseen secondary and tertiary effects of policy and regulatory changes that could reverberate throughout the industry in many unexpected ways. Studying and framing the problems is essential to not repeat the errors of the past and rightly aim to meet the operation demand of the RCAF concept of operations for the twenty-first century.

CHAPTER 4: RECRUITEMENT, LOYALTY AND DEDICATION FACTORS

INTRODUCTION

Recruitment, loyalty, and dedication are all enabling factors when considering the type of maintenance and its workforces required for the twenty-first century. Reviewing the key attributes and elements which positively influence maintenance leaders to improve motivation with their personnel is essential in this research project. Many factors that come into play in the equation will be discussed with respect to the motivational influence of maintenance personnel over their career and why their joined the organization in the first place.

This chapter will outline an overview of why Canadians join and remain in the forces, how does the type of maintenance organization affect they loyalty and dedication, and how can the RCAF used the experience gained from the civilian industry to further its readiness endeavour for the twenty-first century.

STRUCTURE

As previously discussed in a chapter 2, one factor that is commonly agreed upon is the noticeable influence on the type of maintenance organization in which maintenance personnel belong; usually an AMS or a SAMEO within a flying squadron. From past and recent collective experience, air maintenance squadrons (AMS) have generally experienced more perplexing struggles to motivate its personnel due to a multitude of factors compared to SAMEO organizations. The difference is amplified by the type of training, workload, and hours of operations expected by the different chains of command.[141] This situation emanates from the disconnect between maintenance personnel working in an AMS with respect to the feeling of

[141] Rheaume, Eric. Towards an Equilibrium between RCAF and Contracted Maintenance Following the Procurement of the CF-188 Replacements. JCSP 43 Master of Defence Studies. 2017. 50-51

contributions towards operations taking place at the wing.[142] Without sustained information distribution, maintenance personnel never fully understand their direct role on the operations such as SAR and North American Aerospace Defence (NORAD) Command missions.[143] Therefore, the burden of motivation falls on the shoulders of officers and senior NCOs to impart, explain, and promote the roles and impacts that maintenance personnel have on operations. This task is also shared with the wing's perspective of attributing success to a single unit; for example, a flying squadron is often congratulated or highlighted in the media without taking into account the multitude of support network nodes, including AMS maintenance personnel that actively contributed to the successful delivery of a mission capable aircraft. That is where squadron based maintenance, such as a SAMEO organization usually yields better results in from the perspective of motivation than a centralized concept of an AMS due to the fact that they cannot be distinguished from the whole squadron. Therefore, when the entire squadron receives congratulatory remarks and mentions, all its flights naturally feel proud of their accomplishments. This is a completely different situation than the AMS.[144]

The author believes that the AMS is still undoubtedly a solid requirement of twenty-first century maintenance architecture. Nevertheless, it should focus on providing specific centralized services such as maintenance library support, metal workshop, and non-destructive testing (NDT) capabilities versus first line capabilities. First line maintenance capabilities should be embedded in flying squadrons to foster and promote a team mentality attitude where

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[142] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 167

[143] Ibid. 167

[144] Based on the author's experience as Deputy SAMEO at 435 Sqn Winnipeg from 2007 to 2009 and as CO of 19 AMS Comox from 2016 to 2018.

maintenance personnel can understand and sense that their contribution and work directly matter in successfully accomplishing objectives.[145]

Another interesting and valid parallel to the civilian industry is the fact that civilian aircraft maintenance has the ability to directly enhance the customer satisfaction and sense of security in many ways that often deal in the emotional realms of passengers. This fact is often overlooked and not completely considered by civilian senior managers when promoting airlines through advertising and media.[146] The maintenance records of an airline is not often the main factor considered by managers and as matter of fact possible customers which will become paying passengers. It can be considered as a non-factor when all goes well but in the event of an accident or incident related to maintenance, it can great affect the public's perception if deficiencies in maintenance are distributed by the traditional and social media. Airlines can even take action on such public's perception and hide it under a statement such a "evolving commercial reasons."[147] This was the case of the Canadian airline Sunwing in the first days of the second crash of the Boeing 737 MAX 8, where it decided to ground its fleet of MAX 8 despite the fact that Transport Canada had found enough technical and airworthiness evidence take such measure at this time. As more information became available the decision was taken by Transport Canada and Sunwing Airlines continued with their grounding decision. Sunwing

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[145] English, Allan and Westrop, John. *Canadian Air Forces Leadership and Command: Human dimension of Expeditionary Air Forces Operations.* Department of National Defence. 2007. 167

[146] Johnson, Bill. *From the FAA –The Role of Maintenance in Corporate Customer Service.* Aircraft Maintenance Technology. May 2017. 2017. 39

[147] Canadian Broadcasting Corporation. *Sunwing suspends Boeing 737 Max 8 flights for 'evolving commercial reasons'*. Canada. 2019

Airlines' decision was not based on technical information but on the customer's perception only.[148]

The objectives are different in nature for the RCAF maintenance community. They are not focused on the customer's satisfaction and increased profits, but rather on the missions completed and valorization of the maintenance personnel's contribution to the mission success. The referenced article states the following criteria as part of a civilian maintenance checklist: 1) Fitness for Duty; 2) Communication; 3) Strict abidance of technical publications; 4) Voluntary reporting such as the RCAF flight safety program for the CAF; 5) Peer-to-Peer observation; 6) Continuing Process improvements alight with the AF9000 Plus quality management; 7) Conveying competence and Professionalism; and 8) Customer's Viewpoint.[149] All except one defined criteria which strongly resonate with the maintenance procedures and airworthiness principles instilled as the foundation of the AERE and maintenance technicians. They range from being fit for duty to augment one's readiness and mental abilities, effective communication skills, following the CFTOs, following the fair and just system of the flight safety program, promoting continuous improvements, and increasing the squadron or unit pride in the missions, and quality of workmanship. The only one that is not implemented in an official manner is the Peer-to-Peer observation in which technicians provide feedback to each other in order to improve members' technical competencies with the goal on increasing aircraft safety.[150] This process would be beneficial for the RCAF maintenance community to instill a formal culture of peer-on-peer evaluation focusing on technical expertise in a manner to complement the currently personnel evaluation reports (PER). This method could perhaps include leadership and

[148] Canadian Broadcasting Corporation. *Sunwing suspends Boeing 737 Max 8 flights for 'evolving commercial reasons'*. Canada. 2019

[149] Johnson, Bill. *From the FAA –The Role of Maintenance in Corporate Customer Service.* Aircraft Maintenance Technology. May 2017. 2017. 39

[150] Ibid. 39

management aspects with the goal of improving a member's proficiencies in the mastery of airworthiness and maintenance procedures. The overall objective is for airworthiness and maintenance procedures be strictly followed and improved in the spirit of continuous improvements by maintenance professionals in order to become effective enabler of the operational concept for the RCAF.

GENERAL AVIATION MANUFACTURER ASSOCIATION

Along the same lines, one of the factors to consider during for the recruitment aspect is how to entice and interest the new generation in wanting to become a RCAF's aircraft technician or AERE officer. Similarity to what the RCAF is facing can be seen in the civilian industry as it too is beset by concerns and strategies to ensure in appealing to the younger generation. Therefore, in order to get more interest in the next generation of maintenance professionals, the civilian industry has decided to actively target youths by carefully analyzing the reason why they decide to embark in the aviation and maintenance world. A survey conducted by the Manufacturing Institute found that the number one reason is the student's own interest followed closely by the parents or family members' influence.[151] Hence the experience and perspective from the member working in the industry is crucial in how they will discuss and showcase the benefits and disadvantages of such a career. This reality is very similar to the military in many ways, where often a family member or a person in the youth's surroundings are key in positively influencing their decision. CAF and RCAF members often forget that they are true ambassadors of the CAF in their daily lives. Their actions, works and discussions can leave an impact of the type of organization the Canadian Armed Forces is and aspires to be. This factor is the same

[151] Bunce, Pete. *Celebrating the Next Generation of Maintenance Professionals: the Journey that the led them to aviation.* GAMA Insight. Aircraft Maintenance Technologies. August/September 2018. 2018

with respect to selecting aircraft maintenance trades when applying at the CAF's recruiting centre.[152]

The upcoming shortage of qualified maintenance personnel is a reality that affects many air forces but also the civilian airline industry. Boeing has forecast that up to 754,000 new aircraft maintenance technicians will be required for the next 20 years to support and maintain the global civilian industry.[153] From this upcoming demand for skilled workforces, the company has acknowledged the requirements for taking a proactive approach, combined with industry and educational outreach program, in order to inspire and recruit the next generation of maintenance personnel. Henceforth to tackle the potential shortfalls, the General Aviation Manufacturer Association (GAMA) has decided to directly address the solution by directly targeting the parents of the next generation of maintenance professional by starting initiative such as "parent night" to showcase the career benefits such as pay, working in a world in constant innovation, and longevity of employment.[154] They realize that by informing the parents, they might become the influence and potential support for the children to pursue a career in this field.

The National Aviation Academy (NAA) based in Florida and Massachusetts also work along the same lines to stimulate and recruit the next generation of maintenance personnel by focusing on overall benefit of this employment environment.[155] Their method targets the next generation by first exposing them to the advantages of the career in aviation and maintenance, while positively influencing the parents with progressive aspects of the industry address both

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[152] Canada. National Defence. *Duty with Honour – The profession of Arms in Canada*. A-PA-005-000/AP-001. 2003. 61

[153] Bunce, Pete. *Celebrating the Next Generation of Maintenance Professionals: the Journey that the led them to aviation.* GAMA Insight. Aircraft Maintenance Technologies. August/September 2018. 2018

[154] Ibid.

[155] New Delhi, Contify Aviation News. *Growing Demands in Aviation Maintenance Spark Innovation Leadership ay National Aviation Academy (NAA).* Athena Information Solutions Pvt. Ltd. 2018

criteria emanating from the previously discussed survey. Variances of this technique could be easily used by the CAF and moreover the RCAF to attract the next generation of officers and NCMs for the maintenance community.

The realm of recruiting falls into the domain of responsibilities of the Canadian Forces Recruiting Group (CFRG), which has recruiters that are not always as knowledgeable as required to adequately represent the career's possibilities in the RCAF maintenance community. This situation is not due the deficiencies within CFRG or the shortfalls with respect to the recruiters themselves, but more due to the fact of the vast array of knowledge expected by the recruiters for all the CAF's trades and employment opportunities. Therefore, the recruiter usually possesses a very superficial understanding of aircraft maintenance, and can certainly put the interested applicant or parent in contact with a SME, but sometime due to this extra step the window of interest could be lost if the relevant information is not provided immediately. Recognizing this reality, The RCAF has been using actual maintenance technicians, usually of the rank of Master Corporal to tour schools and technical educational intuitions to give the students and parents an opportunity to discuss and ask face-to-face questions with a genuine maintenance technician.[156] This initiative is championed by the 1 CAD A4 Maint and has yielded great result despite the limited amount of recruiter/technician touring Canada.

Another aspect of this forecasted civilian demand for a larger workforce that will greatly impact the RCAF and other modern air forces is the fact that as demand surges in the coming two decades for maintenance professionals, many of the candidates answering this demand will originate from the air forces. Given the current recruiting and retention structure of the RCAF,

[156] Based on the author's experience and attendance of A4 Maint Council as CO and Senior Maintenance Manager (SMM) of 19 AMS Comox from 2016 to 2018.

this will be problematic due the fact that not only will it generate a competition to recruit the best candidates, but it will increase the incentive for currently serving members to voluntary release for better opportunities on the civilian side. Thus, the RCAF must focus its attention on two fronts; first in actively recruiting the next generation of maintenance officers and NCMs; and secondly by enhancing the retention program to keep its workforces. Actively keeping technicians on the same fleets, if they desire, until the ranks Sargent or Air Maintenance Superintendent (AM Sup) is a good start but the challenge of geographical stability is the largest obstacle to address. Staying within the same fleet is more solvable by using the levers of trade senior occupation advisor (SOA), 1 CAD A4 Maint, and Chief of Military Personnel (CMP) using return on investment strategies with respect to the technical expertise and maintenance corporate knowledge. However, the issue of geographical stability is more complex as it involves all the stakeholders of the fleet expertise with the need of the service. The CAF initiative called the "Journey" is expected to provide the tools and architecture for the institution to address partiality or completely many retention challenges including geographical stability.[157]

USA CIVILIAN AIRLINES

The shortage of qualified maintenance personnel is also felt more specifically in the civilian airline industry where it is estimated that the industry could be lacking up to 15,000 qualified personnel by the year 2027. This situation is also affected by the fact the current median age of the US aircraft maintenance worker is 51 years old, with 27 percent being over 64 years old. With the world fleet expected to increase in size by 40 percent over the next 10 years, the situation is anticipated to be more challenging in the coming years unless significant actions are taken by the industry and government entities. Despite these facts, schools and educational

[157] Canada. National Defence. *Strong Secure Engaged – Canada's Defence Policy*. 12

institutions currently do possess the capabilities to train and produce twice the current numbers, which highlights the true root cause of the lack of students.[158]

Over years the fascination with the aviation world and its associated careers have dwindled due several factors that renders it less appealing today when compared to other type of industries.[159] As see in recent years, this situation is clearly affecting the newer generations into embarking in such a career that was considered near-royalty a few decades ago.[160] These factors include the extending work hours, time away from home, and family sacrifices, combined with archaic ways of teaching and antiquated equipment create notably less interest for such career compare to other more stable high-tech employment.[161] In order to counteract this downward trend, the industry started to lobby the governments to put more emphasis on enhancing the appeal of the profession, which resulted in March 2018 by having the US Senate introduce a bill to establish an aviation maintenance workforce development pilot program. The new initiative generated by this bill were, new grants for equipment, scholarships apprenticeships, career outreach activities, and facilitating transition for military maintenance personnel into the civilian industry.[162]

The overall objectives of this initiative were to increase the interest of the population by making the training and employment more appealing in order to improve the number of candidates and applicants. In addition to the bills, the industry, schools and government combined forces to increase the diversity of applicants, focused on competent based process

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[158] Johnson, Bill. *From the FAA - Another Look at the Aviation Maintenance Personnel Shortage and the Solution.* Aircraft Maintenance Technology. June/July 2018. 2018. 12

[159] Ibid. 12

[160] Bakx, Kyle. How the high-flying job of a pilot lost its glamour. CBC News. 2018. https://www.cbc.ca/news/business/pilot-shortage-super-t-atac-wellington-waterloo-1.4471354

[161] Johnson, Bill. *From the FAA - Another Look at the Aviation Maintenance Personnel Shortage and the Solution*. Aircraft Maintenance Technology. June/July 2018. 2018. 12 -13

[162] Johnson, Bill. *From the FAA - Another Look at the Aviation Maintenance Personnel Shortage and the Solution*. Aircraft Maintenance Technology. June/July 2018. 2018. 14-16

instead of program completion, provided competitive and attractive benefits and salaries, provided more up-to-date training equipment for training institutions, offered maintenance facility tours to increase the local familiarity of the local career available, updated the curriculum, and finally ensured the teachers were fluent in current pedagogical skills.[163] Furthermore, a new hybrid pilot program was approved by the Federal Aviation Administration (FAA) in which students have thirteen months of online distance learning, seven months of residential instructions, and lastly a certification exam in order to confirmed the technical knowledge, hands-on skills, troubleshooting abilities, and learning aptitudes to perform in the aviation world.[164] This recognized situation is definitely similar in many aspects to the RCAF and how it could potentially manage some of it recruiting issues. Under the CAF's current career progression and succession ideology, the challenges of work and life balance are difficult to mitigate like the civilian industry. This is mainly due that under their progression or succession career planning paths members are expected to progress towards achieving higher ranks and always striving to move upwards.[165] However, it can be addressed by slight but noticeable iterations focusing in providing greater stability to maintenance personnel for geographical stability and allowing them staying on the same fleet. These steps are already address as required but cannot be formalized with affecting substantial aspect of the career management with the RCAF.

Another interesting initiative that could be easily being implemented and delegated at the wing level is offering free facility tours to recruit local candidates. With wings such as 8 Wing

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[163] Ibid. 2018. 14-16

[164] Johnson, Bill. *From the FAA - Another Look at the Aviation Maintenance Personnel Shortage and the Solution*. Aircraft Maintenance Technology. June/July 2018. 2018. 16-17

[165] Canada. National Defence. *Duty with Honour – The profession of Arms in Canada*. A-PA-005-000/AP-001. 2003. 23

Trenton, 17 Wing Winnipeg, 12 Wing Shearwater being in or near major Canadian cities, this idea would likely be well received by the local high schools, vocational training establishment, and parents. Modernizing the equipment, providing more pedagogical training to instructors and supervisors, looking a distance learning alternatives, and increasing the intake capability of the Canadian Forces School of Aerospace Technology and Engineering (CFSATE) in CFB Borden would positively affect the output of maintenance personnel within the RCAF.

Another interesting aspect was the impact of the terminology when defining maintenance workers. In the US and Canada, aviation personnel are referred as "mechanic" or "technician," whereas they are called "engineer" in the most of the rest of the world.[166] In Ontario, the term "engineer" or "ingénieur" is referred to only professional engineers with certified and approved credentials which include specific degrees, adequate professional experience, and having successfully completed ethical and legal exams in the professional responsibilities of assuming these duties.[167] This terminology is similar within other Canadian provinces and territory. The intent of this regulation is to ensure the public is protected by a professional body that adheres to specific experience and experience for its members in a regulated association. This is not the same in other countries and jurisdictions such as in Europe, which can lead to confusion for the greater public. Along the same lines, the RCAF still has the trade of flight engineer but it is more tied to historical lineage of the Second World War and the decades that followed than the actual professional responsibilities associated with the position.[168] Hence, this changing the

[166] Johnson, Bill. *From the FAA - Another Look at the Aviation Maintenance Personnel Shortage and the Solution*. Aircraft Maintenance Technology. June/July 2018. 2018. 14

[167] Government of Ontario. Professional Engineers Act. R.S.O. 1990, Chapter P.28. 2018

[168] Government of Canada. Fly what you fix: Become a Flight Engineer. The Maple Leaf. 2016. https://ml-fd.caf-fac.ca/en/2016/11/1112

terminology of the names would require changing in provincial acts, which would be less than ideal for the CAF and RCAF.

CONCLUSION

This chapter as addressed the determining factors of recruitment, loyalty and dedication to the RCAF as an organization but also as an employer of choice. It discussed the reasons why people join and why they stay, and how the structure of maintenance organization, AMS versus SAMEO, greatly matter in the equation. The sense of direct contribution is key in ensuring members feel valued in operations. The upcoming global shortage of maintenance personnel was also described with several key leaders in the industry targeting parents or family members to stimulate interest in the next generations. In the US, the industry lobby has been able to influence the government in setting guidelines to enable the changing of minds toward career in this field, providing more grants for newer equipment in training institutions, and scholarships for interested candidates.

The RCAF has instituted a recruitment initiative using actual aircraft maintenance technicians to improve the number of candidates and provide face-to-face opportunities for interested applicants. With this in mind, it highlighted the impact that a RCAF member can have one his or her surrounding and community. They are ambassadors for the CAF and RCAF in many ways in or out of uniform. They can positively influence potential candidates in applying in the RCAF as aircraft technicians. With programs like the Journey, the CAF could solve some the issues that will arise in the upcoming years and decades, which should soften the impact with recruiting and retention aspects.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

INTRODUCTION

This research study reviewed the status of the CAF and the RCAF with respect to the current state of the aircraft maintenance community, and how it must adapt to the requirements driven by the RCAF concept of operations in the twenty-first century. It has demonstrated that the RCAF maintenance community must be considered ready to face the challenges of the twenty-first century RCAF's operational concept. It outlined that the challenges in achieving this objective include a maintenance structure that has not really changed since the early 1990s, a maintenance philosophy that has not embraced the new technologies and their enabling characteristics, a way the institution develops and trains it workforces of maintenance professionals with expectations of higher education and enhanced critical thinking, and challenges with respect to recruitment, loyalty and dedication of its members. Many of these factors can be controlled and managed by the CAF and RCAF's policies; however other more significant ones come from powerful industry players such as US airlines and manufacturers such as Boeing Inc.

Chapter 2 discussed the structure and inner workings of the maintenance community and how it was built out of BAMEO organizations into what we know today: AMS and SAMEO flights. From the references and assessments, the RCAF is moving towards the right direction in standardization of nomenclature, and by reviewing its positions to determine the benefits of introducing civilian or contractors to enhance the corporate knowledge and training capabilities. It must also look at changing it maintenance philosophy to focus more on the long term perspective versus the short to the medium ones, and actively foster a critical thinking environment to achieve the ability to frame actual problem and solve them in a durable fashion.

Chapter 3 addressed the large situation of training and developing true maintenance professionals possessing higher education with sound critical thinking abilities to leverage experience of the last decades into a successful foundation for the future. The AERE officers and AM Sup are considered to be one of the critical chains for success in this endeavour as the position exerts leadership, management, and vision for the over the maintenance community. By looking at other air forces such as the USAF, USN, US Army Aviation, and RAAF, all experiencing shortages, career planning difficulties, lack of tangible experience combined with limited training of troubleshooting skills, the RCAF can understand the problems and used the available lessons learned to develop a plan to solve many issues with a Canadian flavour. The changes can be carried out be using new tools such as virtual reality, new methodology fatigue and aging aircraft reality, and new policies enabling a change from a traditional preventive and reactive maintenance concept into a predictive maintenance concept. From this the maintenance community can put a pause in significant changes for a foreseeable future, unless operationally required, truly frame the problem and set the guidelines for durable success despite posting cycle and change of leadership in key positions. With such approach the maintenance community can generate technologically savvy leaders with critical thinking skills to face, adapt and solve the unforeseeable issues in the coming years.

Chapter 4 established that the current recruitment and retention models need to be altered in order for the RCAF to become an employer of choice. By determining why people join the RCAF and why they stay, can provide the core foundation for the organization to focus in program such as the Journey. As the civilian industry realizes the coming shortfall in workforces and initiates new means to attract new application such as “parents’ night” and lobbies governments to enact new bills, grants for equipment, and scholarship; the military air forces

cannot stay idles and watch from the sidelines. This is of the utmost importance as the military personnel are one of the noteworthy targets for the civilian industry gaps. Therefore, the RCAF must continue with using its own aircraft technicians to active recruiting, and look at option with respect to offering tours to the civilian population around its Wings, and tackle the geographical stability issue as it one of the most pressing problem which years result in significant portion of voluntary releases. With these changes and amendment, the RCAF can be able to effectively compete in the job market in the coming years.

CONCLUSION AND RECOMMENDATIONS

The path to success is not an easy one and it will require disrupting and forward thinking to address challenges and effectively solve them in manner that will set for success the maintenance community for the twenty-first century. Many members of the maintenance community, including this author, realize that stay competitive and relevant as a national air power, the RCAF must look at ways to remain at the cutting edge of thinking better than its enemies. The posting cycle philosophy must be revised and actual aircraft experience in a formal manner must be taken into account for the institution but also for the member's individual needs. The roles of maintenance must be communicated using new media and tools by key leaders as it is capable of improving loyalty and dedication for the organization.

The traditional way of performing maintenance using preventing and reactive approaches must be enhanced with modern tools to incorporate the new predictive method. Training must be more inclusive of new technologies as well, not just at the educational institutions such as CFSATE but also at the first and second line units. Furthermore, institutional changes must be studied with a more comprehensive lens to frame the problems and attempt to determine and

influence secondary and tertiary effects. To be effective many of these plans must focus on the members themselves. A critical aspect of this is ensuring members understand their roles and direct impacts on operations, especially when taking into account that the apprentices and junior technicians will emanate from the millennial and Gen Z generations. Communication and forward agile thinking will be necessary in ensuring the RCAF's maintenance community has the means to undertake it roles given in the twenty-first century. Thinking towards the future will require the RCAF to incorporate new technologies and ways of performing aircraft maintenance by leveraging the lessons learned from its past and other air forces, and organizations such as the RAWC to ensure it can be successful in the twenty-first century.

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