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CREATIVITY COUNTS: ENHANCING THE DGAEPM QUALITY PROGRAM

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Abstract

Responding to resource pressures, diminishing experience levels and airworthiness concerns, the CF aerospace engineering and maintenance community commenced a number of change initiatives in the early 1990s, including the development of a new quality standard. A key feature distinguishing the new system, AF9000 Plus, from its predecessor is a continuous improvement directive. Although every CF maintenance organization is required to implement a unit-specific quality program, this task is particularly challenging for the DGAEPM Division in NDHQ. The introduction of new fleets with disparate support strategies, the prominence of airworthiness-related duties, and the demands to sustain all CF aircraft fleets, necessitate a unique degree of creativity. This paper examines the importance of innovation in sustaining continuous improvement, and recommends the use of a second-generation knowledge management strategy to promote ingenuity and foster enhancement of the DGAEPM quality program. This strategy is based upon a combination of knowledge distribution and knowledge generation, which is encouraged by establishing a working environment conducive to formulating and implementing new ideas.

Why would anyone want to promote creativity in the control-oriented and compliance-dominated discipline of aerospace quality assurance? The environment is inherently risk-averse because of the scale of damage and loss of life associated with aircraft accidents. Generally speaking, it is accepted that there is a need to establish and maintain a competitive edge in both the civil and military aviation communities, in terms of profitability in the former case, and war-fighting capability in the latter circumstance. In this regard, innovation plays a critical role in both environments because of its leverage effects relative to the opposition. But ingenuity may also be important in the development of aircraft-related quality programs, particularly if new activities are assigned or if modern equipment is not suitably addressed under the existing system. These are the circumstances that confront the Aerospace Equipment Program Management (AEPM) Division in NDHQ today. Indeed, the challenge has been there for several years, and is unlikely to wane within the foreseeable future.

While compelling requirements to address experience shortfalls, limited funding and airworthiness deficiencies prompted a thorough review of the Canadian Forces (CF) aerospace quality system from the mid nineties forward, a continuous improvement obligation mandates on-going review of all AEPM activities. Further, the turnover in aircraft fleets that has been occurring in recent years and the current focus on airworthiness renewal, prompted by a DG Audit review in 1994,[1] continue to stimulate a demand for upgrades to a relatively new quality program. How does one sustain this seemingly insatiable call for enhancement? The key factor is the AEPM Division's ability to be innovative.

[1] BGen E. Morin, *The Airworthiness Program - The Action Plan* (National Defence Headquarters, Ottawa: file 11500-YF-568 (DGAEM), 28 Nov 94), pp 1-2.

This paper will establish that a second-generation knowledge management strategy to promote creativity would facilitate sustainable continuous improvement of the DGAEPM quality system. In order to demonstrate this point, the significance of creativity and some relative impediments will first be presented. Subsequently, an overview of the CF quality program will be provided to show that the requirement for creativity in the AEPM context is unique within the CF aerospace community. Finally, a strategy for sustaining continuous improvement is proposed, based upon encouraging and facilitating creativity.

A 1996 article in the *Harvard Business Review* defines innovation as "the successful implementation of creative ideas within an organization."[2] Thus, it follows that innovation and creativity are tightly linked. Specifically, creativity deals with the generation of knowledge and new concepts, whereas innovation is the mechanism for bringing the ideas into effect. This being the case, innovation cannot occur without some degree of creativity. The nature of any resultant change might be as limited as the restructuring or re-sequencing of existing objects or practices, or as revolutionary as a radical approach to deal with a new challenge. Regardless of the scale, there is something novel generated as a consequence of the application of ingenuity.

Creativity is widely cited as an important attribute of profitable corporations. Indeed, some have argued that increasing creativity enhances the probability of success.[3] The requirement to stimulate creativity and innovation is also a key feature of the transformational model of leadership, which Northouse opines is increasing in

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[2] T. Amabile, qtd. in Mary Jane Grant's "Welcome to the Innovation Age," in *Managing for Success*, ed by Monica Fleck (Toronto: Harper-Collins, 1999), p 36.

[3] James Knight, "The Mind Game," *Design Week*, Vol 17, Issue 36 (5 September 2002), p 19.

popularity.[4] Military organizations, including those in Canada and the United States, have also acclaimed the importance of innovation and include it amongst the essential characteristics of their personnel.[5] Consequently, military leaders, in particular, have an obligation to both recognize and foster creativity in individuals, and to promote innovation within their working groups. While it is the leader's task to set the tone and establish the vision for his team, it is not sufficient to simply ensure that everyone shares the same goal. Rather, members must "feel the freedom, indeed the expectation, that they can use their initiative and creativity to achieve the vision."[6] However, there are factors that have the potential to constrain creativity within groups, two of which, organizational issues and information technology, are particularly relevant in the military context.

Janowitz observes that attempts to stimulate initiative within groups are stifled by the organizational bureaucracy, which, he asserts, is typically widespread in military organizations.[7] He opines that resistance to innovation is centred in the middle management layer where "ceremonialism" and "organizational rigidity" caused by the "prerogatives of rank" inhibit creative problem solving.[8] Similarly, Cole notes that upper management can also constrain ingenuity due to what he refers to as "trained incapacity."

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[4] Peter G. Northouse, *Leadership: Theory and Practice* (Thousand Oaks, CA: Sage Publications, 2001), p 131.

[5] Gen J.M.G. Baril and J. Judd, *Shaping the Future of the Canadian Forces: A Strategy for 2020* (National Defence Headquarters, Ottawa, June 1999), p 8, and Ronald E. Zimmerman, Jr., "Looking for the Perfect Leader," *Engineer*, Vol 30, Issue 3 (July 2000), p 17.

[6] John W. Woodmansee, "Unleashing Human Potential: The Leader's Role in Creating the Climate for High Performing Organizations" in *Leadership: The Warrior's Art* ed by Christopher D. Kolenda (Carlisle, PA: Army War College Foundation Press, 2001), p 346.

[7] Morris Janowitz, *Sociology and the Military Establishment* (New York: Russell Sage Foundation, 1965), p 46.

[8] *Ibid*, p 103.

Authoritative both in terms of position and attributed expertise, senior managers tend to influence the actions of their subordinates. Yet their experience may generate blind spots due to an inability to perceive subtle, yet distinct, features of a new situation. Mistakenly, they may apply inappropriate solutions because they fail to recognize the unique characteristics of a problem. Worse still, they tend to immerse themselves within the information or knowledge structures with which they are familiar, and remain relatively isolated from novel business practices or ideas.[9]

Information technology (IT) can also be an impediment to innovation because increased reliance upon electronic data management systems encourages a tendency to resort to what has been done before. Databases replete with success stories and failures provide a guide as to what may or may not work in a given situation. Given the availability of ready-made solutions, however, there is a temptation to adopt them, without regard to the current scenario, a phenomenon that Janowitz suggests is especially prevalent in some environments. Specifically, he notes that "automated decision-making devices ... are particularly compatible with rigid hierarchical conceptions of military organization."[10] Perhaps an even more significant concern is the degree to which one's competence is eroded by dependence upon previous solutions. As one author opines, reliance "on IT in the decision-making process ... can atrophy an individual's capability to make sound judgments."[11]

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[9] Robert E. Cole, *Managing Quality Fads: How American Business Learned to Play the* Game (New York: Oxford University Press, 1999), p 47.

[10] Janowitz, *Sociology* ..., p 104.

[11] Mary Crossan, "Learning to Use Information Technology for Competitive Advantage," in *Managing for Success*, ed by Monica Fleck (Toronto: Harper-Collins, 1999), p 52.

Presuming that most problems have at least one unique feature, which distinguishes them from previously encountered circumstances, existing solutions must be tailored to the particular nuances of the predicament. This demands some degree of ingenuity in order to develop the optimum course of action. Given the afore-mentioned obstacles, however, military staffs are challenged to stimulate creativity in a less than ideal environment. Even so, leaders must overcome these barriers if they hope to improve upon the quality of the answer to a question at hand and, by extension, sustain the proficiency of their personnel. To make the circumstances even more daunting, it is particularly difficult to promote creativity within an organization whose business imperatives include coordination and control.[12] The aerospace milieu is a case in point.

The aviation industry, whether military or civil, is faced with the challenge of balancing safety requirements and innovation. Aircraft accidents, regardless of cause, are widely reported in the press and elicit public concern. Recent examples, such as the Swissair 111, TWA 800, and American Airlines Flight 587 crashes, are cases in point, and the associated loss of life is a reminder that the consequences of failure are often significant. In the military context, performance requirements, such as speed and manoeuverability, result in aircraft designs that push the limits of technology, in order to achieve an advantage in combat. Even so, reasonable safety margins must be maintained to minimize training and other non-combat losses. As clearly stated in the CF policy on flight safety, it is imperative to protect aviation resources.[13] Considering the importance

[12] Teresa M. Amabile, "How to Kill Creativity," *Harvard Business Review*, September-October 1998, p 77.

[13] Department of National Defence, A-GA-135-001/AA-001 *Flight Safety for the Canadian Forces* (Ottawa: DND Canada, 2002), p 1-1-1.

of human life and the value of aircraft assets, it is not surprising that military and civil regulatory agencies have been established to promote and monitor aviation safety.

It is essential to recognize that regulations require civil and military authorities to conduct specific tasks and to implement particular procedures to ensure that aircraft are, and will remain, airworthy, or fit for flight. The Aeronautics Act is the over-arching directive in Canada. It assigns exclusive responsibility for matters concerning civil aviation to the Minister of Transport, and those related to military aircraft, both foreign - while operated in Canada - and domestic, to the Minister of National Defence.[14] Each Department establishes rules guiding the performance of airworthiness activities within its sphere of influence. In both cases, the Departments insist that a quality assurance program be implemented to ascertain that every maintenance organization is conducting its work in accordance with the regulations. However, the two Departments differ in what they specify for a compliant program. In the civil case, the Minister of Transport simply requires a program that is consistent with standards published by Transport Canada.[15] In contrast, the military approach requires use of a CF-unique quality system, which is to some extent based upon the internationally recognized ISO 9000 quality standards.[16]

The prescriptive approach that was adopted by the CF is useful in achieving a standardized system across the air force community, which was a key requirement when it was brought into effect. At the time of the system's introduction in 1997, the Aircraft

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[14] *Canadian Aeronautics Act*, (Ottawa, Transport Canada, 1985), para 3.

[15] Transport Canada, *Canadian Aviation Regulations* (Ottawa: Transport Canada, 1995), Part V, Subpart 73, para 573.09.

[16] Department of National Defence, C-05-005-001/AG-001 *Technical Airworthiness Manual* (Ottawa: DND Canada, 2001), p 1-6-2-1.

Engineering and Maintenance (AEM) community was facing a number of resource challenges, consistent with those endemic across the CF. Average experience levels had been dropping in the mid 1990s due to the large number of new personnel who had joined in the late 1980s and early 1990s. For example, some 500 Aerospace Engineers became occupation qualified between 1989 and 1993.[17] When combined with the Forces Reduction Program initiative from 1993 to 1995, which brought about the departure of more than 400 aircraft engineers,[18] who typically had more than 10 years commissioned service, it was clear that there was a shortfall in experienced personnel. In the same time frame, the Department was undergoing a series of restructuring exercises to align the new manning levels with mission requirements in a period of budget reduction.[19] There was a well-founded concern that important services would be inadvertently dropped as a consequence of the consolidation and disbandment of some Directorates in NDHQ. One example of this phenomenon was the disappearance of the NDHQ section that was responsible for packaging and storage standards. The lack of specialty advice in this area was a root cause of the CF Boeing 707 main landing gear failure in 1996.[20] Taken together, the diminishing experience levels and numerous organizational changes necessitated the rigid approach that was taken by the CF when the AEM quality system was introduced.

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[17] Maj G.R. Merrill [Merill.GR@forces.gc.ca], "AERE Info," private e-mail message to Maj Donaghy [Donaghy.MJ@forces.gc.ca], 24 April 2003.

[18] Maj P.P. Beland, "AERE Specific Briefing - 2003 Promotion Year" (annual career presentation by D Mil C 4-9), slide 15.

[19] Department of National Defence, C-05-005-P11/AM-001 *A Quality Standard for Aerospace Engineering and Maintenance* (Winnipeg: DND Canada, 1999), Parts 1 and 2.

[20] Maj D.T. Smigelski, *Final Report on B707 MLG Failure* (National Defence Headquarters Ottawa: file 11500YD-568 (DTA 2-2), 28 February 1997), p 6.

The new CF aerospace quality system, which is referred to as AF9000 Plus, espouses continuous improvement as one of its key principles.[21] Continuous improvement is a term that came into vogue with the Total Quality Management (TQM) business philosophy dominant in the 1980s.[22] Some have asserted that one of its underlying principles is that greater value should be placed upon s2 0 0 12 461.916s0 12 130.00513 52 Tm(i

ad hoc basis. Creech suggests that a more holistic approach is required. Specifically, he recommends that a planned review should be the exception, and that personnel should be encouraged to not only identify, but also pursue improvement opportunities on an on-going basis.[26] It is noteworthy that the AF9000 Plus system is not only prescriptive, but process-oriented, with a focus on "prevention first, correction where necessary and eventually reaching a state of continuous improvement."[27] Further, all AEPM quality documents must undergo a directed review every eighteen months by the original author, who is designated as the "process owner."[28]

In practice, two factors are impeding the CF's ability to implement an optimum quality system, limited application of the continuous improvement principle and a lack of innovation in the processes, themselves. On this first point, the scope of continuous improvement within AF9000 Plus is limited to what Philip Crosby, author of *Quality is Free*, refers to as "the four basic absolutes of quality management: the definition of quality is conformance to requirements, the system causing quality is prevention, the performance standard for quality is zero defects, and the measurement of quality is the price of non-performance."[29] One need only look as far as the headline description of the AF9000 Plus quality system on the AEPM website to realize that the focus is on compliance with written instructions - "say what we do - do what we say" has become the

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[26] Bill Creech, *The Five Pillars of TQM: How to Make Total Quality Management Work for You* (New York: Penguin Books, 1994), pp 216-218.

[27] C-05-005-P11/AM-001, Part 2, paras 4-5

[28] No author listed, *Documentation and Data Control of Quality Management System (QMS) Map* (DGAEPM Ottawa: file QS05.001/e, 24 October 2002), p 6.

[29] Cole, *Managing Quality Fads ...,* p 86.

mantra of AF9000 Plus proponents.[30] Yet, this is neither a requirement of the ISO 9000 standards,[31] nor is it consistent with a continuous improvement mindset. Errantly, it appears that the AF9000 Plus system considers the "plan-do-check-act" cycle in a quality control context[32] rather than from a continuous improvement perspective.[33] Regardless of the rationale for this approach, the AF9000 Plus interpretation is inherently self-limiting. Specifically, improvement is being construed as a reduction in the number of discrepancies between what is done and what should have been done, in accordance with the process documentation. Consequently, the best that can be accomplished in this situation is a zero-defect rate in the goods and services that are delivered by the respective organizations that operate under this quality system. At that point, by definition, no further improvement is possible.

In a true continuous improvement environment, the processes are constantly subject to scrutiny. Quality enhancements can either be achieved by exercising better control through the process, or by establishing new standards of performance as a result of innovative change.[34] The advantage of the latter approach is that it generally results in step improvement, as opposed to a gradual change, in product quality. This is not to say that the importance of improved quality control initiatives should be downplayed. Rather, they should be encouraged because they provide for sustainable continuous

[30] No author, "Map-on-Line" [admmat219.ottawa-hull.mil.ca/af9000/whatis_e.asp], no date.

[31] David Hoyle, *ISO 9000 Quality Systems Handbook* (Oxford: Butterworth-Heinemann, 1997), p 41.

[32] *Ibid*, p 13. See Annex B.

[33] Carr and Littman, *Excellence in Government ...,* p 22. See Annex B.

[34] Hoyle, *ISO Quality Systems Handbook ...,* p 16.

improvement between the innovative changes, which tend to occur less frequently.[35] Although all CF AEM organizations share these weaknesses in the continuous improvement of their quality programs to some degree, the impact is more pronounced in the Aerospace Equipment Program Management (AEPM) Division because of the breadth of the assigned tasks.

The scope of activities conducted by the AEPM Division is extensive, ranging from certification of new CF aircraft to disposal of aviation assets. DGAEPM oversees many aspects of the in-service support program, including approval of changes in the maintenance program for every CF aircraft, acquisition of aircraft spares, and acceptance of the work done by contractors. Unlike the unit level maintenance organizations, whose primary task is to implement servicing, inspection and repair activities, the AEPM Division is responsible for developing policy and managing change. As such, there is a greater demand for creativity in the AEPM environment. It should not be inferred that there is not scope for initiative at the units. Discrepancies in publications and improvements in maintenance procedures are commonly identified by technicians while conducting specific tasks. However, the nature of maintenance activity in the units is typically recurring, whereas the work in the AEPM Division tends to be more diversified and non-repetitive.

These differences in the scope of activity conducted throughout the AEM community necessitate a unique quality plan for each organization. Consequently, the AF9000 Plus program requires that each establishment document how it conducts its activities in a unit-specific Manual of Aerospace Practices (MAP). This is comparable to

[35] Carr and Littman, *Excellence in Government ...,* p 20.

the Transport Canada requirement for each civil aircraft maintenance organization.[36] The MAP describes how each organization conducts its business processes, in support of its mission, whereas particular maintenance procedures are detailed in aircraft technical manuals. Typically, as is the case for the AEPM MAP, the process documents are published in electronic format to facilitate ease of access.

As noted previously, a "say what we do - do what we say" philosophy was embraced when the AF9000 Plus system was adopted. This offered a couple of advantages, which simplified the transition to the new quality program. First, it allowed the developers to focus on the procedures that were in place, and avoid implementing changes concurrent with the preparation of the documents. As such, it could serve as a useful baseline for subsequent improvements. Secondly, it facilitated a relatively prompt launch of the program. Given the resource constraints and experience levels at the time and the implications relative to airworthiness, as identified in the DG Audit report, it was important to establish the program quickly. The airworthiness considerations were particularly important in view of the relative infancy of the DND airworthiness program - the Technical Airworthiness Manual was not issued until 2001.

Like many organizations within the Department of National Defence, the work conducted by the aircraft maintenance and engineering community is continuing to undergo dramatic transformation. Some activities, such as the certification of new aircraft, are in their infancy. Others, such as aircraft equipment disposal, require significant attention due to concern about the use of compatible military parts in commercial aircraft. While many former CF aircraft, including the CC109

[36] Transport Canada, *Canadian Aviation Regulations* (Ottawa: Transport Canada, 1995), Part V, Subpart 73, para 573.09.

Cosmopolitan, CC137 Boeing 707, CH136 Kiowa, and CH135 Twin Huey had similar civil counterparts, the differences were more pronounced than is the case with the newer CH146, CH149, and CC150 aircraft, each of which has a civil-certified contemporary. Given these circumstances, it is not sufficient to simply continue to do what was being done in the past. Rather, it is necessary to formulate new procedures to address this work.

The requirement for AEPM staff to deal with change is extensive. In the airworthiness context, the ability to develop methods to deal with new situations is a fundamental and persistent challenge. The CF is currently managing two major design changes, which have not been previously approved - both the CF18 and CP140 Aurora fleets will undergo significant modifications to critical flight systems in the next few years. The CF is also operating two fleets of military registered aircraft, which are not owned by the Crown, the CT155 Hawk and the CT156 Harvard II. This unique arrangement is without precedent in Canada. Further, two of the CF's fleets, the CC150 Polaris and the CC144 Challenger, are wholly supported in accordance with civilian airworthiness standards. Finally, in the case of the CH146 Griffin and CH149 Cormorant helicopters, a blend of civilian and military maintenance systems is used to sustain the aircraft. While most flying units deal with no more that a few aircraft types on a continuous basis, the AEPM Division has a mandate to support all CF aircraft; albeit, to varying degrees. Given the diversity in the support strategies for the various fleets, a "one size fits all solution" is not appropriate.

The current situation is not an anomaly. Rather, it reflects the requirement to be innovative when establishing support programs or formulating design changes for CF

aircraft fleets. Since this is an on-going issue, it is important for the AEPM Division to promote creativity, not only to develop the new practices that are necessary to support recently added fleets, but also to encourage continuous improvement in the procedures that are already in place. Further, it is insufficient to simply apply creative effort to enhance the processes, in isolation. Rather, it is imperative to establish a culture in which innovative changes will be accepted and implemented throughout the organization.[37]

There are a number of different tactics for promoting creativity within an organization; however, all of them rely upon the generation of "new knowledge" to some extent. The most straight-forward, and perhaps least risky approach, is a form of imitation, commonly referred to as "benchmarking." This practice, which evolved during the nineties, is wholly dependent upon finding an organization that is performing measurably better than one's own. In this case, an organization studies the practices of its peers, or rivals, and attempts to improve upon them.[38] Indeed, the AEPM Division adopted this tactic when it prepared the Technical Airworthiness Manual. Further, this same approach was the premise for the AF9000 Plus Quality System, the "Plus" reflecting the unique aspects of the application of the ISO 9000 standards in a military aircraft context.[39]

In establishing the DND airworthiness program, AEPM staff examined the work of civil organizations, such as Transport Canada, and other military aircraft operators, for instance, those in Australia and Great Britain. In effect, the CF airworthiness manual is

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[37] Creech, *The Five Pillars ...*, pp 218-219.

[38] Sylvia Codling, *Benchmarking* (Aldershot, England: Gower Publishing Limited, 1998), pp 3-4.

[39] C-05-005-P11/AM-001, Part 1, Para 6.

an amalgam of the features of a variety of similar programs, with a specific Canadian content, where appropriate. A new system was formulated by selecting the preferred features from a number of models and adapting them to CF-unique circumstances. Similarly, the AF9000 Plus quality system was built upon existing standards and added elements, like the continuous improvement requirement, which enhanced its value.[40] In contrast, the AEPM MAP was established exclusively on the basis of the practices that were being used by the Division at the time that it was prepared.

One of the keys to effective use of benchmarking is the ability to measure the relative merits of specific courses of action. It is critical to identify what is being measured and to ascertain that there are no adverse collateral results. If the characteristics of the product or service delivered by a business can be easily quantified, in terms of customer satisfaction, defect rate, service life, or some other metric, then improvement opportunities can be identified more easily. However, selecting the most appropriate item for measurement is one of the biggest hurdles faced by managers at all levels, even in these circumstances.[41] This problem is somewhat moderated by the cyclical nature of many business activities, similar to the majority of unit-level CF aircraft maintenance tasks. But what are the prospects for applying this technique in the AEPM Division case, where the work is less repetitive and the consequences of any procedural change may not be measurable in the near term, if at all?

As was demonstrated with the preparation of the Technical Airworthiness Manual, the value of benchmarking in the AEPM context is realized early on in the

[40] See Annex A.

[41] Codling, Benchmarking, p 8.

change process. By pulling in the best practices from others, an organization can compensate for its own lack of experience when it is initiating a new activity. Consequently, this approach should be encouraged whenever new areas of responsibility are assigned. The second advantage of benchmarking is that it establishes a database of what other organizations are doing. In contrast with lists of internally generated lessons-learned, the work of others tends to be subjected to greater scrutiny and not accepted at face value. There is a greater inclination to seek out the differences from one's own practices, and not directly apply what has worked in the past.[42]

The second mechanism to foster innovation is by establishing a working environment that is conducive to motivating people to be creative. However, there are two prerequisites for this approach, as suggested by Teresa Amabile, a senior associate dean for research at Harvard Business Sccary07 Tficlacky5997invvatigsenia07 Tblng a working

within its work force.[44] Assuming, therefore, that these factors have been addressed, what should managers do to create the conditions necessary to establish and sustain an environment that is conducive to innovation?

Amabile contends that the driving components are intrinsic in nature. Specially, she notes the importance of interest, challenge, and job satisfaction, in the absence of external pressure. Essentially, the motivation to be creative is derived from internal sources. Significantly, Amabile contends that even minor improvements in the working situation result in disproportionately better intrinsic motivation. In this context, management is responsible for setting up an appropriate work environment. As such, she commends six specific areas of managerial influence that can affect creativity: challenge, freedom, resources, work-group features, supervisory encouragement, and organizational support.[45] Dr. William R. Klemm, a former Colonel in the U.S. Air Force, who was employed for eight years as a scientific researcher in the Human Systems Division, makes similar observations, relative to a military context.[46] Although Amabile and Klemm speak to the issue of internal motivators, it is equally important to establish an extrinsic working environment that is conducive to innovation. As McElroy notes, creativity, or what he describes as knowledge production, is fundamentally a social process. His thesis is that a new idea must be accepted before it is practised, which implies a requirement for interaction within groups.[47]

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[44] Baril, ... *A Strategy for 2020*, p 8.

[45] Amabile, "How to Kill Creativity," p 80. Details on each can be found in the reference.

[46] Dr. William R. Klemm, "Leadership: Creativity and Innovation," [http://www.au.af.mil/au/awc/awcgate/au-24/au24-401.htm], no date, p 8.

[47] Mark W. McElroy, *The New Knowledge Management: Complexity, Learning and Sustainable Innovation* (Burlington, MA: Butterworth-Heinemann, 2002), p 134.

The conventional view of knowledge management[48] holds that its purpose is to enhance the diffusion of existing information throughout an organization to facilitate its performance. The emphasis is on integration and access.[49] Based upon features such as "say what we do - do what we say" and electronic accessibility, the AEPM Division scheme for its quality program is an example of this strategy. While this approach may be suitable for a static situation, it is less effective when the business activity is subject to change, either because of continuous improvement initiatives or new requirements. Given the current and anticipated activity, it is imperative to emphasize knowledge generation as well. As McElroy points out, the key to sustainable innovation is a balanced combination of knowledge distribution and knowledge production, which he refers to as second-generation knowledge management.[50]

Based upon the expectation enunciated by former CDS, Gen Baril, and the increasing prominence of electronic databases within the CF, it is evident that the importance of knowledge distribution is recognized. In contrast, there has been less attention directed toward knowledge generation. McElroy suggests that there are four key principles through which management may stimulate "significant gains in learning, innovation and competitive performance." These main ideas are embryology of knowledge, politics of knowledge, intellectual diversity, and connectedness.[51] The first of these points refers to the freedom that individuals can employ to explore their own learning opportunities, and organize into informal groups with a common interest. The

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[48] McElroy, *The New Knowledge* Management …, p 196.

[49] *Ibid,* p 5.

[50] *Ibid,* p 133.

second principle relates to organizational rigidity and the negative impact on innovation that is imposed by channelized attention. The third concept addresses the importance of supporting a multitude of ideas, including dissident opinions, to foster creativity. The final principle identifies the importance of breaking down the information "stove-pipes" between work-groups. Notably, this sphere of influence, overall, aligns with Amabile's observations on the importance of organizational support, supervisory encouragement and work-group features.

The potential value of these four principles to the AEPM Division, in the context of its quality program, is appreciable. Learning opportunities external to the group should be exploited, whether through formal training with other organizations such as Transport Canada, or by consulting with specialists who have the appropriate expertise. This would help to alleviate the current lack of experience, promote understanding of activities that are new to the Division, and foster creative dialogue across organizational boundaries on common areas of interest. In addition, the lack of restrictions on self-organization would encourage teamwork, improve the communication between groups and help to dispense with the stovepipes typical of bureaucratic organizations. Finally, the application of these principles would promote a more collective approach to the challenges that face the Division. Rather than simply relying upon the process owners to review the MAP, individual users should be encouraged to share new ideas, especially if their experience with a particular problem necessitates adaptation of existing procedures. This would better facilitate continuous improvement of the quality program.

Creativity plays an important role in establishing the effectiveness of any organization, particularly when it is charged with the development of new practices and

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[51] McElroy, *The New Knowledge Management* ..., pp 136-137.

lacks the requisite experience. In these circumstances, benchmarking may be a suitable technique for establishing initial competency, but it will not necessarily deliver sustainable innovation. In contrast, the presence of a working environment that promotes the generation of knowledge, and ensures its diffusion throughout the business, will enhance the probability of continuous improvement. Why should the AEPM Division be motivated to adopt a second-generation knowledge management strategy? Simply stated, "the only sustainable competitive advantage, is the ability to learn faster."[52]

The diversity of AEPM Division activities is a unique feature within the CF aerospace community. Given its broad mandate and the need to constantly adapt to evolving weapons systems support strategies, the AEPM Division must have the capacity to be innovative in the development and implementation of its quality program. The benefits of creativity in enhancing the performance of business and military establishments are widely recognized. Consequently, this is an avenue that must be exploited in order to advance the AEPM Division quality program. As noted in this paper, significant impediments to ingenuity can be readily overcome through a managerial focus on the culture that exists within an organization. Recognizing that social issues directly effect the extent to which innovative ideas are adopted within a group, it is imperative to foster an environment that promotes rationale scrutiny and acceptance of new ideas, and supports their implementation. A balanced approach, which addresses both the generation and dissemination of knowledge, and imparts and encourages an innovative working environment, offers the optimum way forward. Thus, true continuous improvement of the AEPM quality system can be sustained through effective application of a second-generation knowledge management strategy. Given the

[52] McElroy, *The New Knowledge Management* ..., p 134.

Division's responsibility for airworthiness and the continuing pressure on the Department's budget, the adoption of a methodology that promotes creativity in the AEPM quality program is not only timely, it is compelling.

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EXECUTIVE SUMMARY[53]

(The "What" and "Why" of AF9000 Plus)

Part 1 - What is AF9000 Plus?

AF9000 Plus is a quality management philosophy. It uses a "systems" approach to management that encompasses various aspects, including:

1. Establishment of ***standards*** that define ***what*** is required of organizations;

2. Training in process assessment and evaluation resulting in the establishment of ***documented procedures*** intended, by design, to ensure that process "output" (products/services) meets specified requirements. This document defines ***how*** things get done;

3. ***Standardization*** of not only the quality system, but also systemic processes and procedures. This also provides a means for assessing compliance with all regulations as well as increased interoperational capability and readiness; and

4. ***Continuous improvement*** to ensure the quality system remains relevant to organizational goals/objectives, and practical to the operation of the unit.

Following the "Plan – Do – Check – Act" cycle, the AF9000 Plus quality management approach results in the development of quality systems that adhere to the following basic code:

SAY what you do

DO what you say

PROVE it

AF9000 Plus follows the ISO 9001 standard (the most comprehensive in the series) and adds requirements unique to the air force – hence the "Plus". Essentially, it is a "light-blue" interpretation of the ISO standard, enhanced to meet our needs. The additional elements are Leadership (AF4.1.4), Quality of Life (AF 4.1.5), Business Planning (AF 4.2.3.1) and Continuous Improvement (AF4.2.4). It is worth noting that AF9000 Plus has been recognized by some in the ISO community for these improvements, especially continuous improvement. A major marketing feature of ISO 9000 quality management

[53] No author, "AF9000 Plus Executive Summary" [winnipeg.mil.ca/A4Maint/AF9Kplus/Main_e.htm], c1999.

systems is the ***promise*** or ***expectation*** of continuous improvement. AF9000 Plus makes this a firm requirement to be planned for and achieved.
Due in large part to the similarity between AF9000 Plus and the ISO standards, one question is often asked: Why not just use the ISO standards directly? The answer is simple and found in the ISO standards themselves. The ISO standards describe **what** elements quality systems in general should encompass but not **how** any specific organization implements these elements.

ISO Compendium:1994, pp 67, 68

"It is not the purpose of these International Standards to enforce uniformity of the quality systems. Needs of organizations vary. The design and implementation of a quality system must necessarily be influenced by the particular objectives, products and processes and specific practices of the organization."

The AF9000 Plus standard's structure has also been greatly simplified over the ISO compendium. The CFTO is organized into six parts; Part 4 contains the quality system requirements. Here, the CFTO defines "Requirements" to be met by all participating units. Each requirement is followed immediately by an "Application" section that serves to amplify and clarify where necessary the meaning and intent of the standard. In addition, it offers suggested methods intended to assist units with implementation. Future enhancements will include further tailoring of the "Applications" to various business aspects of the AEM community, such as Software Engineering and Training/Education Units.

Finally, AF9000 Plus has simplified the documentation requirements resulting from implementing a quality system. ISO-based systems require no less than 3 "tiers" in a units' documentation structure. Conversely, AF9000 Plus requires only 2 tiers in a single-source document referred to as the MAP (Manual of Aerospace Procedures). To accommodate various disciplines within a single unit, the unique concept of area manuals has been employed to permit documentation of discreet processes and procedures under the single parent document. In all instances, the unit Commanding Officer is held responsible and accountable for the content of the entire MAP.

Listed below are the primary elements of the AF9000 Plus quality system standard:

AF4.1 – Management Responsibility
AF4.2 – Quality System
AF4.3 – Contract Review
AF4.4 – Design Control
AF4.5 – Document and Data Control
AF4.6 – Purchasing
AF4.7 – Control of Customer Supplied
AF4.11 – Control of Inspection, Measuring and Test Equipment
AF4.12 – Inspection and Test Status
AF4.13 – Control of Non-conforming Product or Service
AF4.14 – Corrective and Preventive Action
AF4.15 – Handling, Storage, Packaging, Preservation, Delivery and Disposal
4.16 – Control of Quality Records
4.17 – Internal Quality Audits

Product, Equipment or Material

AF4.8 – Product Identification and Traceability	*4.18 – Training, Qualification and Authorization*
AF4.9 – Process (Work) Control	*4.19 – Servicing/Post Delivery and In-service Support*
AF4.10 – Inspection and Testing	*4.20 – Statistical Techniques*

There is no argument that the Canadian Forces' "products" are unique; hence AF9000 Plus was developed and designed to support our own organizations needs. Recognizing that quality management systems support a broad range of functions, not just the traditional "quality assurance" and "quality control" activities, AF9000 Plus (at least within the AEM world) is also the basis upon which other program are being developed. The most significant of these is the renewed CF Airworthiness Program. The following excerpts from the draft Technical Airworthiness Manual (TAM) indicate the magnitude and strength of this link:

DRAFT TAM – C-05-005-001/AG-001, Part 1
"**Quality system** Another essential building block in the Technical Airworthiness Program is an effective quality system. An effective quality system is one of the primary means to control the various airworthiness related functions and activities. In this regard, the Air Force 9000 Plus Quality standard for Aerospace Engineering and Maintenance (QSAEM) has been adopted as the standard for the quality system for organizations which are involved in the design, manufacture, maintenance and materiel support of military aeronautical products. Air Force 9000 Plus was developed for implementation in all areas of the CF aerospace engineering and maintenance "from flight line to contractor". It is based on the ISO 9000 model for quality assurance in design, development, production. installation and servicing and tailored as necessary to meet unique DND/CF requirements. All organizations whose mission/function requires airworthiness authority to be assigned must implement a quality system based on Air Force 9000 Plus and have an approved Manual of Aerospace Procedures (MAP) prior to seeking airworthiness accreditation by the TAA. Special consideration or equivalent status may be granted to organizations, particularly civilian contractors who have previously obtained or want ISO 9000 certification. The quality system is the key requirement for organizations involved in the design, manufacture, maintenance and material support of military aeronautical products. The procedures used by these organizations must be documented in a manner acceptable to the TAA."

"1.1.1.4 CONCEPTS
(1) An effective airworthiness program embodies the following concepts:

a. controls and formally documents the delegation of authority including the associated responsibilities and accountability;

b. establishes independence between the regulator (individual who makes the rules) and the implementor (individual who conducts the activity or task);

c. controls the design, manufacture, maintenance, materiel support and operational usage of aeronautical products;

d. ensures the airworthiness of aeronautical products prior to service use;

e. ensures the initial state of airworthiness established prior to service use is maintained throughout the operating service of aeronautical products;

f. ensures that all airworthiness-related activities and tasks involving aeronautical products are conducted under the framework of an effective quality system; and

g. meets the objectives of the Aeronautics Act."

Part 2 - Why AF9000 Plus?

Many factors contributed to the creation of AF9000 Plus; most beyond the direct control of DND or the CF. These include budget and staff reductions (with the associated losses in experience, qualifications, etc), changes in operational tempo and focus, new equipment acquisition, decay of obsolete equipment, etc.

For AEM, the impetus to finding a new or better way to deal with these factors came in the form of a project tasking directive, PD1/95 issued by DCOS Maint in Jan 95. This was primarily a response to numerous cries from tactical-level commanders who felt that more time was being spent by their staff preparing for frequent and uncoordinated headquarters inspections and not on delivering their primary capability - air power. Although the scope of the initial tasking was very broad, it focussed on assessing the ability of HQ staff to continue providing assurances to Commanders that various "outputs" were still in control, and that our collective ability to "get the job done" would be secured well into the future.

In addition to reviewing, cataloguing and assessing numerous (quality) control mechanisms such as inspections, visits, etc., evaluations of both foreign military and Canadian civil sector companies was undertaken in order to benchmark our activities. The need to adopt a quality management system was evident from this assessment. In a nutshell, checklist-based inspections were undertaken by numerous staff to force compliance on tactical-level activities. Detailed observations of errors resulted in the creation of huge reports, with the obligatory unit response on corrective actions taken. The end result being the expenditure of a large-scale effort to force/coerce short-term compliance with little to no long-term benefits.

Staff reductions, especially at headquarters where the majority of inspections were based, directly and negatively affected the ability to continue with such costly inspections. The inspection "pendulum" went from one extreme to the other, resulting in little to no staff activity directed at assessing the "health" of the organization. However, pressure to provide assurances to Commanders that control was still being exercised continued, and

became more important with the creation of increased accountability and delegation of authority to lower levels. Clearly, a new solution is required.

Adopting a quality management systems approach permits the (few) remaining staff to continue with monitoring and regulatory activities, provided at least:

1. Rules, regulations and performance standards be developed and promulgated that clearly define what is expected;

2. Commanders at all levels be provided adequate flexibility to design their systems to fit local requirements, but which remain compliant with established standards;

3. Detailed inspection-based methods are replaced with process-audit techniques where more emphasis is placed on assessing the quality system processes and procedures and not just the day-to-day activities of unit personnel; and

4. There is wide recognition and acceptance of the differences between regulatory activities (assessing compliance to the rules) and enforcement activities (chain of command directives to achieve a particular aim) with full support to separate these as completely independent functions.

The heart of the AF9000 Plus program is the MAP (Manual of Aerospace Procedures). This document, developed by each unit in the air force (including headquarters!), defines their quality system and contains processes/procedures designed to:

a. produce the "output" expected/demanded of the unit with high levels of reliability and repeatability built in;

b. reflect actual workplace activities, hence making it a working document; and

c. be compliant with **all** relevant rules and regulations.

This document not only becomes the primary working manual from which unit personnel receive detailed guidance and instructions on carrying out their assigned duties, it also becomes the primary source of information used by auditors in assessing regulatory compliance. Since all regulatory requirements are to be contained in this single source document, creating natural teams of subject matter expert regulators is not only possible but necessary given the reduced regulatory resources available.

The guiding objective of the AF9000 Plus quality program lies in the need to produce the right product or service at the right time, every time. Emphasis is on prevention of errors/omissions/failures first, correction where necessary eventually reaching a state of continuous improvement.

Finally, the quality management system provides a mechanism for the review and assessment of the effectiveness and efficiency of management processes. The following

excerpt from the AF9000 Plus standard states:

"Audits – General

10. A major aim of the renewed AEM audit program is that a documented, verifiable mechanism is provided for the review [registration] and accreditation of organizations resulting in the formal granting/retention of assigned authority to perform certain functions. The audit program is implemented to ensure continuing compliance with standards and documented processes and that procedures are reflective of workplace operation. As well, audits provide a (management) review mechanism, enabling assessment of process effectiveness and efficiency leading toward a state of continuous improvement. Audits also provide an opportunity for independent validation and verification which assess effectiveness and efficiency of process controls."

Audits take two forms; internal (at unit level) and external (regulatory). Both use the same methods, but differ in focus. They are also complimentary in that audit results are documented and shared.

Notwithstanding the above, there are other, equally significant factors that further justify an "in-house" solution like AF9000 Plus. These include:

1. Control. Regulations, standards policies and orders remain under the direct control of the Canadian Forces, and are not subject to the whims of outside agencies.

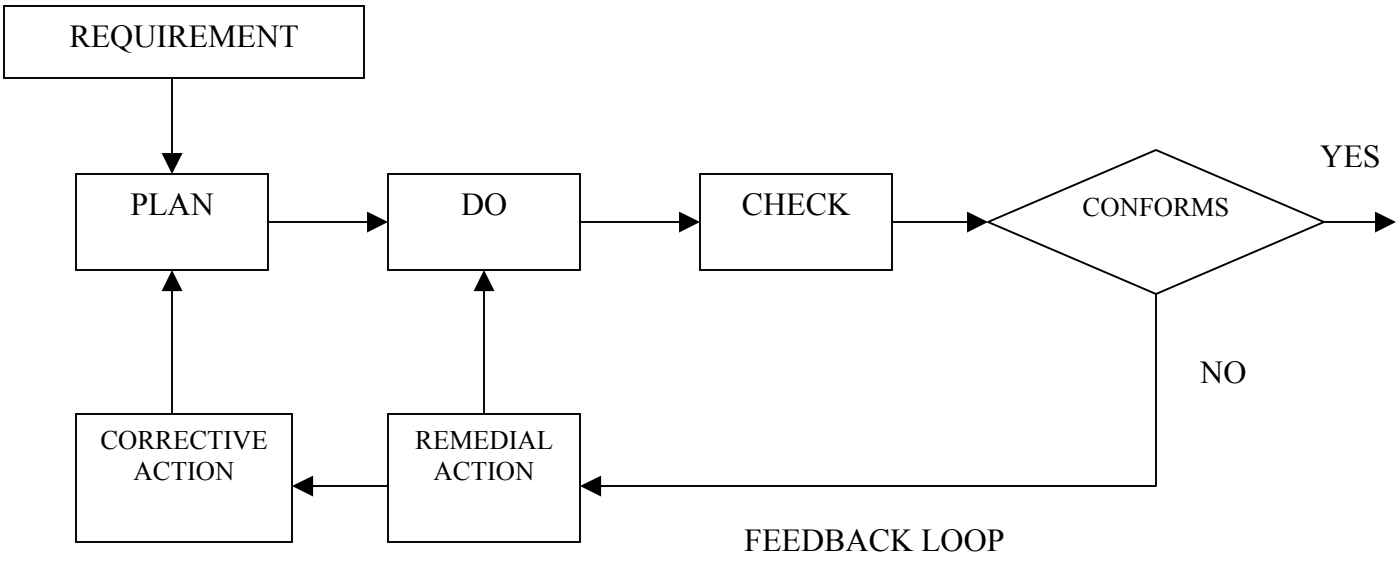
2. Ownership. Ownership of the quality program directly translates to improvements in productivity and morale through a common sense of pride and accomplishment.

3. Cost. Use of internal resources to manage and regulate our system keeps the operating costs down. Use of external control agents can cost $30-$50K per unit. Furthermore, there is no guarantee that civilian regulators will have the requisite knowledge, skills or background in defence matters, resulting in additional costs to educate others in order that they may then better assist us.

As AF9000 Plus implementation proceeds, it is anticipated that the concept behind the program will find its way into other functional areas of the air force besides just AEM. By design, the systems approach of AF9000 Plus permits this collaboration; it will happen out of necessity due to resource reductions, staff limitations and regulatory influence.

ANNEX B
CREATIVITY COUNTS: ENHANCING THE DGAEPM QUALITY PROGRAM

QUALITY CONTROL PROCESS



CONTINUOUS IMPROVEMENT CYCLE