PERFORMANCE-BASED MANAGEMENT AND AIRCRAFT PERIODIC MAINTENANCE

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INTRODUCTION

Organizational strategic planning involves ongoing analysis and reflection, and the definition of clear goals and objectives. However, the resultant strategic plans are often not known to anyone in the organization other than upper management because these plans often lack clear linkages between the strategic vision, the actual required work effort, and informed decision making.[1]

Strategic vision is most often shaped from an informal and unstructured decision-making process by management in response to an organizational need. The conditions for effective decision making are usually missing as this process lacks clear, substantiated facts and accurate performance measurement information. Thus, any resultant decisions are not considered to be truly objective, credible and authoritative. Furthermore, without an effective performance measurement system in place, managers may continue to make significant decisions without having an adequate understanding of the impact of these decisions. From the outset, managers tend to be unaware of the true performance of their processes and have little objective understanding of the proposed process changes. Therefore, a new kind of Integrated Performance-Based Management System (IPBMS) is necessary to align strategy and action, and in a cyclic manner, inform the strategic decision-making process with credible data and context.

The purposes of this article are twofold. First, this article will describe the development of a new IPBMS designed for the Canadian Air Force in response to a need for improved periodic maintenance performance. Over the past 10 years, the Canadian Air Force has seen an unexplained, increasing trend in aircraft downtime associated with the execution of periodic inspections across all fleets. As a result of this increase in downtime and the associated reduction in available operational flying hours, managers have decided to contract periodic inspections to commercial companies at a significant cost to the Canadian military. A review effort, therefore, was undertaken to investigate organizational structure, planning processes, performance metrics, current initiatives, and constraint areas. Ultimately, a new sustainable programme, including an IPBMS, was developed that would allow military units to complete periodic inspections in the shortest time possible with the most efficient use of resources.

However, this new IPBMS would be of little value if there did not exist within it a mechanism by which data and context could be captured and communicated to help inform the decision-making process and organizational course redirection. Thus, the second purpose of this article is to draw attention to the value of process information and the tools and mechanisms introduced within this new integrated system that allow Air Force members to track daily maintenance performance, to manage constraints, and to meet the strategic goal of completing periodic maintenance tasks efficiently and effectively. Ultimately, process information focuses on the way in which work is done and how the results are achieved in an organization in alignment with strategy, allowing for possible course correction at all levels in the organization, including front-line supervisors, operational leadership, and strategic leadership.

This article is divided into three main sections. The first section provides a description of how industry is evolving from simply focusing on performance measuring to the development of integrated performance-based management systems, and the model used in the development of the IPBMS for the Canadian Air Force. The second section provides more in-depth description as to the specifics of the IPBMS developed to assist with improved periodic maintenance performance. Finally, the third section provides details as to the importance of process information as well as the specifics as to how this process information is captured and used to inform strategic direction and redirection.

SECTION ONE – PERFORMANCE MEASURED VERSUS PERFORMANCE MANAGED

Since the early 1990s, organizations have attempted to respond to concerns about aligning business operations with overall strategy by

implementing measurement approaches and tools such as the Balanced Scorecard.[2] This particular approach attempts to create linkage between different perspectives of performance. The effectiveness and efficiency of this measurement tool is extensively discussed within literature and will not be further discussed here. Ultimately, however, the contribution of such measurement approaches depends to a large extent on three conditions: strategy must be translated into operational terms and goals that are clearly understood by management and employees, strategizing must be seen by management and employees as a continuous and fluid process, and there must be improved alignment between processes, services, and competencies within the organization.[3]

To satisfy these conditions, therefore, management must not focus on a particular performance measurement tool but rather on an integrated performance-based management system which is adaptive, accurately depicts the real activities and processes of the organization, and clearly identifies the links to strategy. Organizations must move from simply measuring performance to performance-based management, linking performance measurement to strategic planning, and using it as a lever for organizational change and sustained long-term improvements.[4]

Confusion and a lack of productivity can result when organizations introduce measures and reward systems not aligned with the overall strategic goals. Instead, in this new IPBMS, goals are established by executives based upon validated facts and a common understanding. These goals are then translated into operationalized goals that promote organizational coherence and become the "fabric of the intellectual architecture driving human performance."[5]

Performance-based management is markedly different from simple performance reporting. Performance reporting focuses on communicating results, while performance-based management uses resources and information to achieve and demonstrate measurable progress toward strategic goals.[6] Performance reporting alone is unlikely to drive organizational change and will not trigger improved results.

There are two basic stages in developing and implementing an IPBMS: the foundation stage and the ongoing management stage.[7] The purpose of the foundation stage is to undertake a critical analysis of current conditions and opportunities that confront the organization. During this stage, employees examine basic organization characteristics and document how it operates, including a cost, activity, and process analysis. This analysis represents an assessment of current performance and identifies possible performance gaps. The outcome of the analysis is a comprehensive understanding of the organization and key leverage points. Ultimately, a framework can be created within which executives can establish organization priorities and assign resources, thus causing the organization to perform differently and drive operational change.

The ongoing management stage is concerned with how the information of the previous stage is used in daily business. People work towards achieving the goals, results are monitored, and a cycle of continuous management occurs. Ongoing management involves four basic elements:

- Performance Planned: this element involves operationalizing the goals and conducting an ongoing review of strategy, goals, and budget.
- Performance Managed: this element involves daily performance measurement.
- Decision Support: this element involves the intelligent process of evaluating alternative business choices.
- Work Performed: this element represents the actual work by people and machines and the management of those processes and activities.[8]

Christina Altmayer also described the necessity for ongoing management but suggested there are three tracks associated with this stage and management structure:

Awareness: for this track, managers and employees must see the implementation of the strategic vision as part of their job and

be accountable for not just administering the organizational initiative, but also evaluating whether the initiative achieves the intended results and, if not, to make improvements. In so doing, employees see the connection between their individual job performance and achievement of the organization's mission and goals.

- Development: for this track, managers and employees undertake the tasks associated with performance measurement. Performance measures should include objective measures of quality as well as objective measures of the impact or change to the organization.
- Integration: to be truly performance based, an organization's decision-making processes must be integrated with the use and review of performance measures to effect strategic direction or redirection.[9]

Srikanth Srinivas used a flight analogy to describe effective performance management. Unlike pilots, Srinivas believed that organizations often fail in the foundation stage and do not have a clear understanding of the current reality, and, thus, they are uncertain about the flight destination or strategic goals. This uncertainty results in a poorly articulated flight plan, or operationalized goals, and inevitable struggle with the ongoing management of variation and course correction. Srinivas stated that "there is a widening chasm between strategy and execution, and agile course correction."[10] Therefore, as part of ongoing management, organizations, similar to pilots, must expect variation and be prepared to make necessary improvements or course corrections. Consequently, any effective IPBMS must also provide management with the necessary tools and methods to address, or at the very least, capture the incidents of variation that influence the performance measures and their associated constraints.

As depicted in Figure 1 and using the stages previously described, following a review of current organizational conditions, a strategy is given to the people who take actions

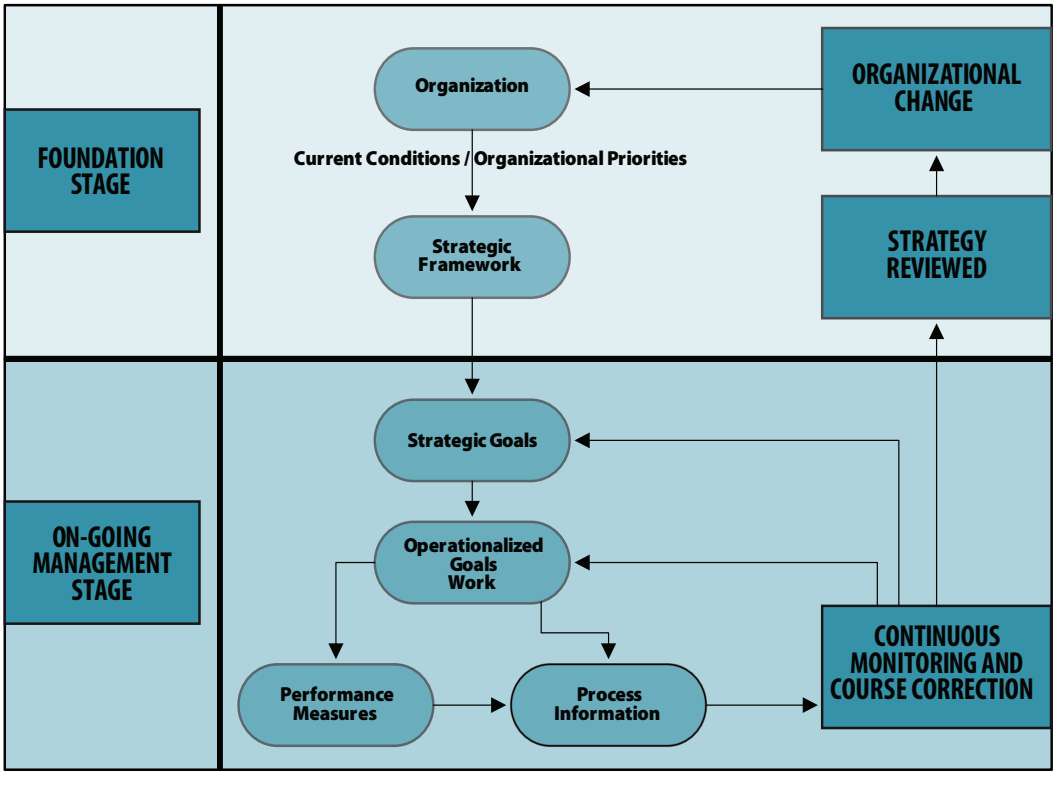

Figure 1. Integrated Performance-Based Management System

through the establishment of strategic and operationalized goals. These goals are defined by performance measures. The linking device of the established measures is activity and process information that focuses on the way in which work is done and how the results are achieved in an organization in alignment with strategy. In a cycle of continuous monitoring, performance and process data can be both a driver and lever in organizational change at all levels, and can foster employee accountability, learning, and collective ownership of organization performance.[11]

SECTION TWO – PERIODIC INSPECTION PERFORMANCE-MANAGEMENT SYSTEM

FOUNDATION STAGE

The foundation stage of the IPBMS developed for the Canadian Air Force began by examining basic organizational characteristics and documenting current operations, culminating in a thorough analysis of the problem. This analysis encompassed a complete listing and review of the challenges and constraints currently being experienced by the Air Force units in their efforts to complete periodic inspection maintenance. Information contained in the problem analysis was based upon the input from Air Force unit reports, results of a working group session, and a general analysis of Air Force documentation and processes regarding aircraft preventive maintenance plans.

More specifically, the problem analysis contained detailed descriptions of the constraints faced by the units at each phase of the periodic inspection work flow process. Constraints were identified and assigned cause-effect relationships with the aim of clearly identifying the root causes associated with increased downtime for periodic inspections. Often, within organizations, management is able to identify the constraints or the undesirable effects (UDEs) that prevent an organization from meeting its stated goal, but the constraint in and of itself is not necessarily the root cause of the larger problem. Few organizations have developed a systematic and logical method of uncovering the root cause(s) and are often unable to gain consensus from all involved as to the true nature of the problem. For this reason, Eliyahu Goldratt suggested that organizations use logic tools to assist in identifying the areas for change. One such tool is Goldratt's Current Reality Tree (CRT), and the use of this tool was employed in the development of the IPBMS.[12]

The intent of the CRT is not to simplify the complexity of the problem, but rather to exercise objective logic to provide links between the UDEs. This approach is preferred over an ad hoc method of determining root causes and serves to convey a system-level understanding of the problem. In the CRT analysis process, a root cause can be classified into either of two categories: a core driver that is considered to be beyond the control of the problem solver but must be managed, and a core problem that is the concern of the problem solver. Upon examination of the CRT, eight root causes were identified and were categorized as below:

CORE DRIVERS:

- lower technician experience;
- unexpected developments resulting in reassignment of resources; and
- no control over varying periodic inspection workload (associated with emergent work from inspection tasks).

CORE PROBLEMS:

- difficult to plan using maintenance card decks;
- lack of performance measures for identifying, tracking, and reporting;
- no control over varying periodic inspection workload;
- unavailability of parts when required; and
- engineering response time not meeting production requirements.

Through the construction of the CRT, it was determined that approximately 70 per cent of all the effects listed on the CRT were linked to the identified core problems. Therefore, it

was determined through the problem analysis that if the core problems could be adequately addressed, then most of the UDEs would be resolved, resulting in more effective and efficient periodic inspection maintenance performance.

As was anticipated from the completion of the problem analysis and foundation stage of this IPBMS, a comprehensive understanding of the organization was obtained and a type of framework was constructed through a doctrine document. This document represented an organizational shift in strategic vision, and included integrated doctrine and policy statements that would allow for the implementation of a new programme for improved periodic maintenance performance. More specifically, the doctrine document contained doctrine statements with links to the identified root causes, outlined key programme components to ensure the long-term sustainability of the new periodic inspection programme, and included a cost-benefit analysis.

ONGOING MANAGEMENT STAGE

To ensure that the information garnered in the previous stage could be successfully translated into a programme for effective ongoing periodic inspection maintenance activity, an integrated performance management structure had to be defined. Without the appropriate management structure and the associated elements, effective organizational change would be unlikely. While Sharman and Altmayer identify four and three key management structure elements respectively, the management structure developed for the Canadian Air Force included the following seven elements grouped according to three management categories. Each element will be further described in the forthcoming section (see Figure 2). However, it should be noted that these categories and elements are not to be viewed as sequential, but rather as overlapping and ongoing areas for development, leading to organizational improvement.

Category 1 - Performance Planned

This category involves determining a common set of methods and frame of reference within which to communicate and address potential problems. It involves operationalizing the goals and conducting ongoing reviews of the strategy, goals, and budget:

- Element 1: Management Methods; and
- Element 2: Centre of Expertise.

Category 2 - Performance Supported

This category represents the identified areas of support necessary in realizing the strategic and operationalized goals:

- Element 3: Training;
- Element 4: Best Practice Sharing;
- Element 5: Provision of Tools; and
- Element 6: Unit Programmes.

Category 3 - Performance Managed

This category represents the daily performance and the management of those processes and activities:

- Element 7: Performance Metrics and Process Information.

CATEGORY 1 - PERFORMANCE PLANNED

Within the first management structure category, Performance Planned, it is necessary to achieve consensus as to a common set of methods to be used in addressing the strategic and operationalized goal(s), as a consistent and focused set of management methods are critical to the success of any complex programme. At this level, there must also be an established mechanism to allow for the ongoing review of strategy, goals, and budget to ensure that processes, services, and organizational competencies can be appropriately aligned. During the development of the IPBMS for the Canadian Air Force, it was determined that Management by Constraints, Critical Path methods, and advanced planning and scheduling techniques should be utilized, and that the establishment of a Centre of Expertise be considered to oversee and fulfill the role of programme champion for this improved periodic inspection initiative. Although method

descriptions will not be provided here as these are readily found in literature, an explanation of why these particular methods were chosen in the development of the IPBMS as well as a more detailed description of the Centre of Expertise will follow.

The primary benefits of incorporating this method were twofold. First, a powerful performance metric structure was constructed that provided timely and accurate feedback on performance, constraint identification, and the effect of the constraint on the goal. Second, an

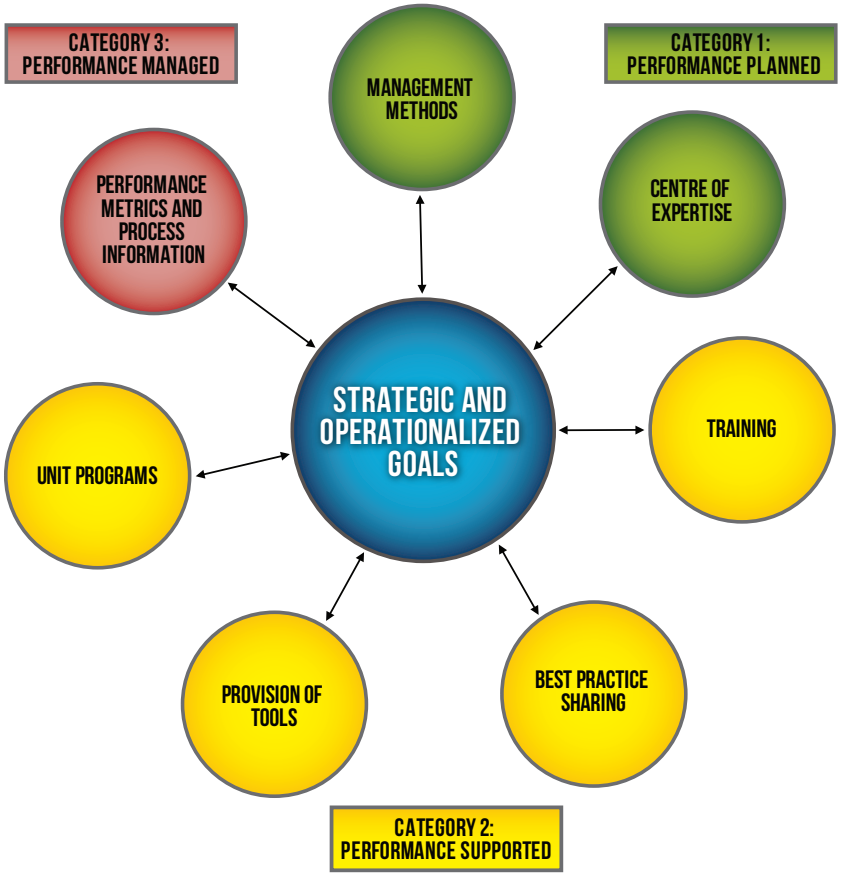

Figure 2. Element 1 - Management Methods

Management by Constraints was adopted due to the extremely dynamic nature of the Air Force environment and the ever-changing nature of the constraints, both within and across Air Force units. In essence, the Management by Constraints method allowed for the continuous and repeated identification and documentation of constraints that influenced each unit's ability to achieve the operationalized goal of completing periodic inspections in the shortest time possible with the most efficient use of resources.

ability to prioritize constraints by the associated level of effect was generated, thereby ensuring that constraints could be resolved in order of priority to meet the goal.

Critical Path Management was deemed to be an essential principle, ability, and skill set for this production-oriented activity. The capability to define and manage the critical path for periodic inspections is necessary for efficient production. The structure and nature of the periodic inspection work package lent

itself well to Critical Path Management, and its application within the new periodic inspection programme resulted in increased inspection velocity and reduced aircraft downtime.

The volume of periodic inspection maintenance tasks and their specific attributes for any given aircraft is beyond the capability of manual scheduling systems. For this reason, commercial advanced planning and scheduling software and techniques had to be adopted into the new periodic inspection programme, and they have had an influence on Air Force periodic inspection productivity.

ELEMENT 2 - CENTRE OF EXPERTISE

An Air Force Centre of Expertise for periodic inspections was considered to be essential for a couple of reasons. Firstly, periodic inspection completion is a production process distinct and separate from daily aircraft maintenance and aircraft generation. Consequently, the skills and knowledge necessary to be an expert practitioner are not widely held across the Air Force, and with high personnel turnover rates, this expertise is difficult to maintain. Secondly, the adoption of a new pan-Air Force maintenance programme would require a programme champion with the responsibility to monitor programme participation, to ensure the continued health of the programme, and to suggest improvements or course redirection when required.

Therefore, more specifically, a Centre of Expertise was established to:

- assist supervisors and managers in ensuring that the strategic and operational goals were being met;
- monitor the advancement of science and technology as well as best practices in other militaries and commercial maintenance providers;
- provide training based on personnel turnover at units;
- maintain core skills and knowledge that cannot be maintained at the unit level;
- ensure continued emphasis on importance of periodic inspection production at the participating units;
- update doctrine and policy as required; and
- monitor key unit performance measures for currency, trends, and effects of improvement initiatives.

CATEGORY 2 - PERFORMANCE SUPPORTED

As previously stated, this category represents the identified areas of support necessary in realizing the strategic and operationalized goals and thus organizational change.

ELEMENT 3 - TRAINING

As a part of the new periodic inspection programme, the Air Force adopted a Just in Time (JIT) training model for personnel responsible for the management and supervision of periodic inspections. The specialty skills and knowledge required, combined with the high rate of personnel turnover, and the relatively small percentage of personnel employed in managing and supervising a periodic maintenance environment, supported the adoption of a JIT specialty training model. This model is triggered whenever an individual is selected for employment in a periodic maintenance environment rather than a general training model that provides training to all personnel and is often triggered by career advancement. The benefits of this JIT training model over a general training model included decreased cost of training and increased effectiveness, as the training was provided to only those individuals with a specific job requirement.

ELEMENT 4 - BEST PRACTICE SHARING

As part of the new periodic inspection programme, it was recommended that the Air Force create and maintain a Community of Practice for periodic inspection practitioners for several reasons. First, given that periodic inspection maintenance across the Air Force takes place in a variety of geographic locations and at varying times depending on the aircraft requirements, little or no opportunity exists for internal benchmarking or idea and information sharing amongst practitioners. Therefore, practitioners must be able to access and communicate externally with other practitioners, both

for benchmarking to assess performance and for idea-sharing to drive continuous improvement. Second, given the high rate of personnel turnover, combined with the distributed nature of periodic inspection work, new practitioners often do not have the opportunity for on-the-job learning from more experienced personnel. A Community of Practice can provide this opportunity. Third, the requirement for specialist skills and knowledge for scheduling and planning are not widely held by Air Force personnel. A Community of Practice can assist in enhancing skills and knowledge through dialogue with other practitioners, thereby creating a virtual learning organization to support and assist practitioners in achieving their goal. And, finally, membership in a Community of Practice serves as a source of motivation to practitioners by providing a forum in which to share their knowledge and reducing feelings of isolation that stem from decentralization.

The establishment of this Community of Practice was achieved through the commencement of the following: a Community of Practice website that provided a common locale where all the Air Force unit personnel could share and publicly discuss their best practices regardless of personal acquaintance, location, or even time zones; quarterly newsletters published by the Centre of Expertise that report unit successes with the intent of keeping members of the Community of Practice engaged and motivated; an annual symposium, organized by the Centre of Expertise, to discuss key issues, initiatives, and possible solutions to common problems that may be occurring; and, an external review, undertaken by the Centre of Expertise, to monitor and investigate external advancements in production management and procedures in other militaries and commercial practices to ensure that the Air Force keeps pace with current best practices.

ELEMENT 5 - PROVISION OF TOOLS

Effective execution of planned and emergent work within a periodic inspection requires the use of advanced planning and scheduling tools. The volume of tasks, the interrelation of resource constraints that affect the execution of the tasks, the dynamic nature of emergent work, and the overall environment are at a level of complexity that requires information technology support to provide key decision information to the practitioner. Therefore, technology was provided to support Air Force personnel, and the provision of these support tools has assisted in an improved yearly flying rate (YFR) generation capability.

ELEMENT 6 - UNIT PROGRAMMES

Ultimately, it is the job and responsibility of the units and Air Force technicians to execute effective and efficient periodic inspections as well as to drive continuous improvement and to develop best practices. Therefore, higher-level organizations such as the Centre of Expertise and the Canadian Air Division must provide the support structure, tools, and motivation necessary to facilitate system-wide solutions. Areas of support include the provision of resources, training, expert advice, and support and advocacy for unit constraints and challenges.

CATEGORY 3 - PERFORMANCE MANAGED

Management of daily performance, work processes, and activities must be ongoing to ensure a cycle of continuous monitoring and improvement. Information garnered from daily management will allow organizations to focus priorities and identify and monitor constraints that may threaten the outcome of realizing the strategic and operationalized goals. Daily management information can inform organizational decision-making processes with credible data and context and thus highlight possible areas of improvement.

ELEMENT 7 - PERFORMANCE METRICS AND PROCESS INFORMATION

Effective performance-based management requires effective performance metrics, as decision making and resource allocation are based on achieving specific performance results, and metrics are explicitly used to measure that progress. In the case of the IPBMS developed for the Canadian Air Force, effective metrics provided the capability to obtain accurate measures of performance; identify and manage

constraints; identify areas of improvement; provide insight to all levels of management and Air Force command; improve baseline planning, including the allocation of resources and time; and, provide commonality between the units, thus facilitating performance comparisons between units and yearly flying trends.

The proposed key performance metric for the Air Force periodic inspection improvement programme included the single output measure of inspection velocity. Inspection velocity represents a measure of the rate at which the inspection is completed, or the progress made each day and any associated constraint. This measure allows for comparison between units, between inspections, and over time, if inspection velocity has been normalized by the number of technicians available to complete the inspection.

Unlike performance metrics of the past that attempted to capture all available information, this performance metric captured the essence of the strategic and operationalized goals and serves as an objective measure of the efficiency of periodic inspection completion. This metric focuses on the rate of work and is independent of the volume of work, and, thus, is not affected by variable workload between inspections and between units. The adoption of this metric shifted the focus at the production level from days to completion to rate of completion, and was considered to be the most relevant and meaningful to strategic and operational decision making.

This performance metric, however, is only useful if effectively supported by additional diagnostic measures, or process information, that provide insight into the reason for either low or high velocity, and consequently, provide the necessary information for possible course redirection and correction. For the IPBMS developed for the Canadian Air Force, process information focused on the impact of constraints associated with inspection velocity, and this impact was communicated either as an impact to the operational YFR or as a velocity issue, requiring unit improvement initiatives. Due to the necessity for accurate and timely process information, a collection system was developed such that this process data could be automatically generated from upgrades to the current user systems and inputs, thereby eliminating any additional overhead associated with performance metric and process information data collection. The specifics of how process information was used to inform decision making at all levels of management will be further described in the upcoming section of the article.

SECTION THREE – PERIODIC INSPECTION PROCESS INFORMATION

As was previously stated, process information focuses on the way in which work is done and how the results are achieved in an organization. The collection of process information requires a mechanism by which the data and context can be captured and communicated to inform decision making at all management levels, including front-line supervisors, operational leadership, and strategic leadership. As is depicted in Figure 3, this new IPBMS developed for the Canadian Air Force allows for the first opportunity for course correction and possible adjustment of the operationalized goals at the front-line supervisor level as daily velocity statistics are collected, hours lost due to constraints are identified, and the average velocity and lost hours are tracked.

The purpose of this information is to capture and communicate the impact of constraints associated with inspection velocity at that particular unit. Once captured, this impact can be addressed through unit initiatives, the development of unit improvement programmes, and the daily management of resources. Performance velocity can also be readily expressed to operational and strategic leadership.

As was required, average inspection velocity was reported to operational management, and the associated constraints were reported as was applicable. However, a requirement for the generation of quarterly unit reports was instituted. Comparing the periodic performance of each unit as well as the associated constraints allows for the possibility of best practice sharing as well as possible course correction and redirection at the operational-management

level through a readjustment of strategic goals. A report capability is planned such that the front-line supervisor can identify the inspection progress in a compatible format with their current tools and technology, and so that a report could be created from the collected information that can summarize the average periodic inspection downtime per quarter for each fleet by unit.

Finally, organizational strategy can be reviewed as the established Centre of Expertise monitors the success of each of the management structure elements mentioned earlier, including management methods, training, best practice sharing, tools, unit programmes, and performance metrics and process information. The extent to which these elements positively contribute to organizational change will be reported annually to Canadian Air Division for ongoing assessment.

SUMMARY

The new IPBMS and associated periodic maintenance programme was introduced to a limited number of Canadian Air Force units. During its introduction, the Canadian Air Force saw a 15 per cent to 40 per cent reduction in downtime associated with periodic inspections for these fleets, and a resultant operational increase of between 4 per cent and 11 per cent. The Air Force now has plans to incorporate the IPBMS into its management policies and for widespread implementation. At the foundation of this IPBMS are strategic and operationalized goals that are realistic and achievable, with a mechanism to allow for these goals to be converted into daily work effort that can be tracked through reportable measures. Additionally, the collection of process information informs strategic decision making and course redirection at all levels of management. ■

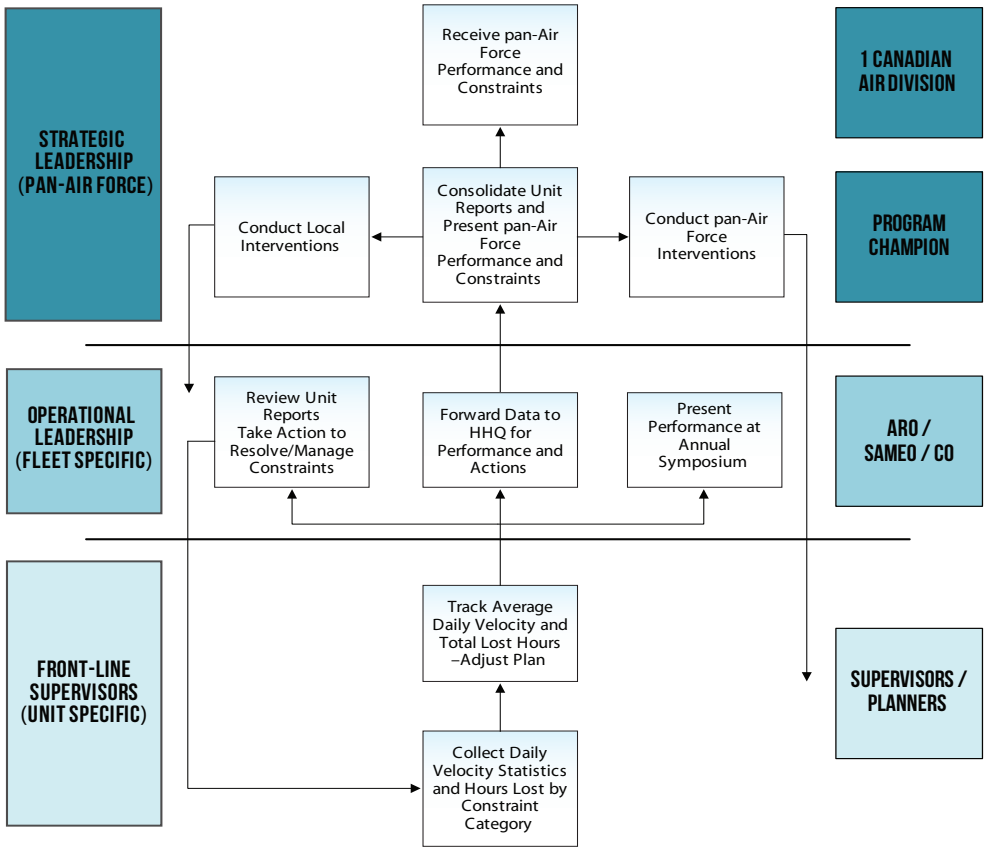

Figure 3. IPBMS Process Information Mechanism

NOTES

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LIST OF ABBREVIATIONS

ARO	**aircraft repair officer**	**SAMEO**	**squadron aircraft maintenance and engineering officer**
CRT	**Current Reality Tree**	**UDE**	**undesirable effects**
IPBMS	**Integrated Performance-Based Management System**	**US**	**United States**
JIT	**Just in Time**	**YFR**	**yearly flying rate**

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MAINTENANCE ANALYSIS OFFICER (MAO) COMMENTS ON ACF ARTICLE PERFORMANCE-BASED MANAGEMENT AND AIRCRAFT PERIODIC MAINTENANCE

A key element in successful business practice is strategic business planning: setting goals and planning for their achievement. Employing effective performance management techniques provides a means of monitoring progress towards the goals and enabling necessary course corrections.

The IPBMS discussed in the article *Performance-Based Management and Aircraft Periodic Maintenance* presents a business system aimed at integrating strategic business practice and effective performance measurement, thereby conducting business more efficiently and effectively. The IPBMS was applied to the Air Force second-line maintenance environment with very positive results.

Canadian Forces aircraft were spending too much time undergoing periodic maintenance. Recognized by 1 Canadian Air Division as being problematic, Operation (Op) PRODUCTION was initiated with the aim to control and reduce the duration of periodic maintenance. The resultant IPBMS elements which were developed are described in the article.

Through the application of the IPBMS, the aircraft periodic maintenance environment was better understood, constraints were identified, applicable data was collected, and performance metrics were developed and employed. Subsequently, managers and decision makers were able to monitor progress and implement changes resulting in improved efficiency and execution of the inspections.

Key personnel were provided training, and practitioners were provided forums to collaborate and share their best practices. Additionally, a new preventive maintenance doctrine was developed, and changes were made to preventive maintenance policy, institutionalizing and providing support from upper management for the new and improved approach to second-line maintenance.

Ultimately, the IPBMS approach for periodic maintenance proved to be thorough and provided practical results. Through the findings observed to date, the application of an IPBMS has been successful in reducing the duration of periodic maintenance.

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