Bilingual staffing within the Canadian Armed Forces

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Abstract—Many positions within the Canadian Armed Forces require incumbents who are proficient in both French and English. However, even with an excess of members that meet these requirements, the success rate for filling these positions with qualified members is low. This problem is examined analytically and it is argued that bilingual staffing will only be successful and efficient if language capabilities are a priority consideration during personnel posting. A detailed mathematical model is constructed that treats the problem of assigning bilingual members to bilingual positions from the point of view of the decision maker. A user-specified lower bound is proposed on the amount of information resources required by a decision maker to overcome staffing constraints while still filling all bilingual positions with a qualified incumbent. The number of bilingual members required to saturate the bound is deemed the optimal (or least costly) number of bilingual members that are required to fill a given number of bilingual positions.

Introduction

Canada is among the growing number of nations to have officially multilingual armed forces (Soeters & van der Muelen 2007). Operations are conducted in both French and English, and a recent report (Canadian Armed Forces, 2015) indicates that 26.7% of Canadian Armed Forces (CAF) Regular Force members spoke French as their first official language. This is slightly higher than the national value of 23.2% as measured in the 2011 census by Statistics Canada (Statistics Canada, 2012).

It is federal policy within Canada to embrace this multiculturalism and respect both official languages as equal. The 1988 Official Languages Act (Revised Statutes of Canada, 1985) outlines the legal obligations of federal institutions with respect to official languages. For example, members of the CAF have the right to use English or French at work in bilingual regions of Canada, and the CAF must respect members’ rights to work in the predominant language of their work region. The act also stipulates that the federal government is committed to “equitable participation” and aims to ensure that francophone and anglophone Canadians have equal employment opportunities.

In the past, the Official Languages Model was used by the CAF to determine which of its units are English, French, bilingual or unspecified language units. These designations were based on the role of the unit and were also made to ensure there were enough French language units to provide career opportunities for Francophone members. As such, each position within the CAF has either a unilingual or bilingual language requirement. The most recent analysis indicates that in 2000 there were 9,969 bilingual positions in the CAF Regular Force, among the 61,346 total positions (Provencher, 2000).

The Official Languages Model is being re-evaluated (Canadian Armed Forces, 2012), and the new designation of bilingual positions will better comply with the Official Languages Act. In light of these changes, this paper investigates the number of bilingual members that is required to efficiently staff bilingual positions within the CAF. In general, successful bilingual staffing requires more than one bilingual member per bilingual position, but requiring too many bilingual members is prohibitive and costly. A balance must be struck between numerous factors such as: increasing bilingual human resources to ensure all bilingual positions are filled successfully; providing members with opportunities for career development; and minimizing the cost associated with training members in a second language. A mathematical model is presented below that prescribes target bilingual staffing levels for the CAF based on these criteria.

This study bears resemblance to other aggregate planning problems in which the size of the workforce is optimized against competing priorities. For example, the classic approach of Holt et al. (1960) derives linear hiring rules from a quadratic cost function to determine optimal workforce levels. One distinctive feature of the present study is that planning...
must be performed based on members’ capabilities, and optimization models have also been constructed with similar
considerations. For example, productivity increases of the entire workforce were investigated by Ebert (1976), while
Khoshnevis (1979) considered explicit worker learning within a mathematical programming model. More recently, the
interplay of technological changes and the learning process was investigated by Gaimon (1997). Other techniques have
also been applied to model workforce capabilities, such as time-dependent dynamical modelling (Gerchak et al, 1990) and
chance-constrained programming, which was used to examine workforce planning in the context of a knowledge-intensive
semiconductor equipment manufacturing plant (Bordoloi & Matsuo, 2000). While these models are compelling, the simplicity
of the qualifications in the problem at hand, and the high priority placed on successful bilingual staffing, lend themselves
to a different approach that is based on the resources available to the decision maker, as shown below.

Background

Bilingual staffing is usually considered by career managers in groups, where a group consists of CAF members with the
same rank and occupation. Within a group, there are \( M \) members and \( N \) positions, and it is assumed for simplicity that
\( M = N \), though this is often not the case in practice. It is also assumed, again for simplicity, that the members of a group
are qualified to occupy any of the group’s positions, and the career manager is responsible for assigning members to positions.
A career manager may assign a unilingual member to a bilingual position, which will be called here an unsuccessful bilingual
staffing assignment.

To quantify this, the success rate for bilingual staffing can be defined as follows:

\[
\sigma = \frac{S_b}{N_b} \tag{1}
\]

where \( S_b \) is the number of bilingual positions that are successfully filled by bilingual incumbents, and \( N_b \) is the total number
of bilingual positions in the group. It is also useful to define the bilingual staffing ratio (BSR),

\[
B = \frac{M_b}{N_b}. \tag{2}
\]

where \( M_b \) is the number of bilingual members available to fill the \( N_b \) bilingual positions, also called here the bilingual
staffing level. As noted above, more than one bilingual member is required per bilingual position, i.e., it is typical that
\( B > 1 \). This is an important requirement since \( \sigma \leq B \) and so completely successful bilingual staffing (\( \sigma = 1 \)) is only possible
when there are at least as many bilingual members as bilingual positions (\( M_b \geq N_b \)).

Historically, the overall success rate of bilingual staffing has been low, despite the fact that the CAF as a whole has had
a BSR in excess of 1. For example, in 2000 the BSR of the CAF was \( B = 1.4 \) since there were \( M_b = 14,385 \) bilingual
members for \( N_b = 9,969 \) bilingual positions. However, the success rate for bilingual staffing was \( \sigma = 0.39 \), since only
\( S_b = 3,865 \) bilingual positions were occupied by a bilingual incumbent (Provencher, 2000).

This problem has been addressed by a number of past models that attempted to determine the BSR necessary for perfect
bilingual staffing (Chouinard & Tseng, 1994; Provencher, 1999). In these studies, historical data were used to examine the
success rate as a function of bilingual staffing levels. The authors performed linear regression on these data to establish a
trend between success rate and BSR, and then extrapolated the trend to \( \sigma = 1 \). The bilingual staffing level required to
achieve this milestone, \( M_b^* \), was presented as the target bilingual staffing level by these models. An example of this procedure is
presented in Fig. 1.

One possible issue with these studies is that extrapolating trends far beyond the data’s range is an unreliable technique
if there is no underlying reason to believe the trend will persist beyond this range. The alternative is that the success rate
does actually depend linearly on bilingual staffing levels. But this is a problem in and of itself, because a success rate
depending linearly on \( M_b \) is the prediction of arbitrary staffing assignment, i.e., career management that does not account
for bilingual capabilities. More precisely, if there are \( N_b \) bilingual positions to be filled and their incumbents are chosen
by a career manager randomly from a pool of size \( M \) that has \( M_b \) bilingual members, then the expected success rate
depends on these parameters as follows:

\[
\langle \sigma \rangle = \frac{\langle S_b \rangle}{N_b} = \frac{M_b}{M}. \tag{3}
\]

where angle brackets denote expected values, and they are calculated using the hypergeometric distribution appropriate to
this type of problem (Johnson et al, 1992). This relation is also plotted in Fig. 1.
Figure 1. The target BSR predicted by linear extrapolation, and the expected success rate as a function of BSR.

Above, a sample scenario is plotted for a group with $M = 160$ and $N_b = 100$. The vertical line represents the BSR at which every member of the group is bilingual, $B_{\text{max}} = M/N_b = 1.6$. In the first plot, data is represented by points and the linear fit to data is shown. In the second plot, the straight line represents the prediction of Equation (3), and the dashed line shows the expected success rate according to the Wallenius distribution, which includes a bias towards placing bilingual members in bilingual positions (Johnson et al., 1992).

These plots show that an indiscriminate approach to bilingual staffing requires a great deal of bilingual personnel resources, since $\sigma = 1$ if and only if $M_b = M$. If career managers are not accounting for bilingual capabilities when choosing staffing assignments, then the only way to ensure perfect bilingual staffing is to require that every member be bilingual. It should therefore come as no surprise that target bilingual staffing levels of $M_b^* > M$ were a common prescription of past models (Provencher, 1999). This is true of the example above, since the fit line in the first plot reaches $\sigma = 1$ when the BSR exceeds the value indicated by the vertical line.

These models and associated policies were conceived at a time when the aim of the CAF was to improve language capabilities throughout the entire forces by providing members with numerous second language training opportunities. It has since been concluded that this approach “spread the CAF’s significant total (second language) resources across the entire CAF, which meant that while widely applied it failed to yield the depth necessary to achieve compliance” with the Official Languages Act (Canadian Armed Forces, 2012). In other words, promoting widespread bilingualism did not effectively solve the problem of low bilingual staffing success rate.

In light of these observations, the new goal of the CAF is to “confirm official languages human resource requirements” and “optimize linguistic capacity-building methodology” (Canadian Armed Forces, 2012). As this discussion suggests, successful bilingual staffing cannot be achieved efficiently without staffing assignments that actively account for the second language capability of CAF members. So the question of bilingual staffing is no longer, “How will an increase in bilingual personnel increase the bilingual staffing success rate?” Instead, it is more pertinent to ask, “What is the optimal number of bilingual personnel required by a career manager who is systematically staffing bilingual positions?” The latter question is confronted by the model below.

**Position Assignments**

This model adopts the point of view of a career manager that prioritizes successful bilingual staffing, subject to the constraints described in the introduction that:

a) all bilingual positions must be filled successfully
b) members must have adequate opportunities for career development
c) the target number of bilingual members should be minimized to minimize the cost of second language training
In a given year, a certain proportion \( \Gamma \) of the group requires a new position, so a career manager is responsible for assigning \( m = \Gamma M \) members to \( n = \Gamma N \) available positions in that year. It also follows that an average member spends \( \tau = \Gamma^{-1} \) years in a given position. Since it is assumed that there is one member for each position in the group, it follows that

\[
M = N \implies m = n. \tag{4}
\]

From the total number of members, there are \( m_b = \Gamma M_b \) bilingual members that need a new position annually, and there are \( n_b = \Gamma N_b \) bilingual positions that need to be filled by new members. Each member and position is either unilingual or bilingual so that

\[
m_b + m_u = m = n = n_b + n_u, \tag{5}\]

where a \( u \) subscript denotes a unilingual quantity. Finally, it is also assumed that the number of bilingual members exceeds the number of bilingual positions, \( m_b \geq n_b \), so that perfect bilingual staffing is possible.

From the career manager’s point of view, a decision must be made on how this bilingual staffing assignment should be made. There is a total of \( p = m! \) options available to the manager. However, only some of these options satisfy criterion a) by filling each bilingual position successfully. The number of ways to put \( m_b \) bilingual members into \( n_b \) bilingual positions is given by

\[
w_b = \frac{m_b!}{(m_b-n_b)!}, \tag{6}\]

and for each way of doing this, the remaining \( n_u \) positions can be filled arbitrarily, so that the total number of bilingual staffing options is

\[
p_b = w_b n_u! = \frac{m_b! n_u!}{(m_b-n_b)!}. \tag{7}\]

This quantity is problematic because it counts staffing options where a member is put into the same position that they previously occupied. This does not represent the actual number of options available to a career manager, who must ensure that every member is moved to a different position than they previously occupied.

To properly compute the number of staffing options available to a career manager, only the staffing options in which every member is moved should be considered. These will be called staffing reassignments.

In the mathematical literature such a permutation is known as a derangement, and the principle of inclusion-exclusion (Roberts & Tesman, 2009) can be used to calculate the total number of derangements, or reassignments. In the present context, the principle dictates that the number of staffing options with zero unmoved members is the total number of staffing options, less the number of staffing options with at least one unmoved member, plus the number of staffing options with at least two unmoved members, and so on. To wit

\[
d = \binom{m}{0} m! - \binom{m}{1} (m-1)! + \binom{m}{2} (m-2)! - \cdots + \binom{m}{i} (m-i)! - \cdots, \tag{8}\]

where the \( \text{choose} \) function is counting the number of different ways that \( i \) of the \( m \) members can be fixed, and the \( p(i) = (m-i)! \) factor counts the number of ways the remaining members can be placed. The definition of the \( \text{choose} \) function can be used to rewrite this result

\[
d = \sum_{i=0}^{m} (-1)^i \binom{m}{i} (m-i)! = m! \sum_{i=0}^{m} \frac{(-1)^i}{i!}. \tag{9}\]

The issue, once again, is that some of these staffing reassignments violate criterion a) since they assign unilingual members to bilingual positions. So Equation (9) must be generalized to include only successful bilingual staffing reassignments, and this represents the number of staffing options that are truly available to a career manager who prioritizes successful bilingual staffing. The difference between bilingual and unsuccessful reassignments can be seen in Fig. 2.

In the diagrams above, the top row represents the initial condition of the group members: Bil A is in position 1, Bil B is in position 2, Bil C is in position 3 and Uni is in position 4, where positions 1 and 2 are bilingual (blue, square) while positions 3 and 4 are unilingual (red, circular). The lines represent the position reassignment by indicating the new position of each member; each member is placed in a new position, so these options are indeed reassignments. In the first staffing reassignment, each bilingual position is filled by a bilingual incumbent. In the second reassignment, position 2 is assigned to Uni, who is not bilingual, so this reassignment is unsuccessful.
The number of successful staffing reassignments can also be calculated using the inclusion-exclusion principle, and appropriately summing assignments where members are unmoved. However, in the bilingual case, there are three different types of members that can remain unmoved. There are $n_b$ bilingual members who are in bilingual positions, there are $m_b - n_b$ bilingual members who are in unilingual positions, and there are $m_u$ unilingual members in unilingual positions. So the choose function in Equation (9) must be generalized as follows

$$\binom{n_b}{j} \binom{m_b-n_b}{k} \binom{m_u}{l}. \quad (10)$$

This quantity counts the number of ways to fix $j$ bilingual members in bilingual positions, $k$ bilingual members in unilingual positions and $l$ unilingual members in unilingual positions. A total of $i = j + k + l$ members are fixed.

The next step is to calculate the number of ways the unfixed members can be placed, subject to the constraint that the staffing assignment must be bilingual. It is given by:

$$p_b(j, k, l) = \frac{(m_b-j-k)!}{(m_b-n_b-k)!} \times (n_u - k - l)!,$$

where the first factor counts the number of ways that $m_b - j - k$ available bilingual members can be placed in $n_b - j$ available bilingual positions and the factor of $(n_u - k - l)!$ counts the number of ways that the unfixed unilingual positions can be filled. This generalizes the result in Equation (7) to account for fixed members.

Finally, these quantities must be combined and summed according to the principle of inclusion-exclusion, which gives the final result for the number of bilingual staffing reassignments

$$d_b = \sum_{j=0}^{n_b} \sum_{k=0}^{m_b-n_b} \sum_{l=0}^{m_u} (-1)^{j+k+l} \binom{n_b}{j} \binom{m_b-n_b}{k} \binom{m_u}{l} p_b(j, k, l). \quad (12)$$

This is the number of staffing options available to the career manager that satisfy criteria a) while ensuring that each member is reassigned. A nontrivial confirmation of this result is that $d_b = d$ when every member is bilingual, which can be proven. Examples can be found in the table below.

<table>
<thead>
<tr>
<th>$n$</th>
<th>$n_b$</th>
<th>$m_b$</th>
<th>$d_b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4</td>
<td>4</td>
<td>2,385</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>6</td>
<td>59,985</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>8</td>
<td>374,001</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>8</td>
<td>119,193</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td>16</td>
<td>$8.785 \times 10^{15}$</td>
</tr>
</tbody>
</table>
their career interests. Alternatively, they might have just completed a similar posting, or there may be a geographic limitation. These types of constraints fall under criterion b) and the goal of this section is to construct a mathematical condition that determines when there are enough bilingual staffing options available to a career manager to satisfy b). The minimal value of \( M_b \) that is required to satisfy this condition also satisfies c) by being the least costly option, and this gives the target number of bilingual members, \( M_b^* \).

As a career manager is given access to fewer bilingual members, it becomes more difficult to satisfy criterion b), since the number of available bilingual staffing reassignments, \( d_b \), decreases. There is a point at which the career manager does not have enough flexibility to choose an appropriate bilingual staffing option that ensures career mobility of the members. For example, suppose there was just one bilingual staffing reassignment, \( d_b = 1 \). In this case, there is absolutely no flexibility in the career manager’s decision, and any additional career management constraints not related to language capability would be impossible to satisfy.

To quantify this notion, a measure of the decision making resources available to a career manager, as a function of the number of bilingual staffing reassignments, \( S(d_b) \), must be constructed. From the considerations above, it should obey

\[
S(1) = 0,
\]

which says that a single bilingual option leaves a career manager with zero decision making resources.

Next, consider a career manager that must make staffing assignments for two subsequent years. There are \( d_b \) possible assignments in the first year, and for each of these there are \( d_b \) possible assignments in the second year, which gives a total of \( d_b^2 \) possible staffing options. Since the two decisions are independent, the flexibility or resources available to make the two identical decisions should be twice that of a single staffing decision

\[
S(d_b^2) = 2 S(d_b).
\]

There is one unique function that has these properties, and up to constant \( \kappa \) the function \( S \) can be identified as the logarithm

\[
S(d_b) = \kappa \ln(d_b).
\]

These arguments are commonly used in information theory (Klir, 2006), and the quantity in Equation (15) is the Hartley entropy, or uncertainty, associated with bilingual staffing decisions. It represents the amount of information that is gained when a specific choice of bilingual staffing reassignment is selected. It is for this reason that \( S(d_b) \) can be thought of as representing the decision making resources available to a career manager.

It is worth noting the immediate parallels between this discussion and the fundamentals of statistical thermodynamics (Carter, 2001). From this point of view, \( S \) is the entropy associated with the bilingual staffing reassignment macrostate, for which there are \( d_b \) microstates. More entropy corresponds to a greater flexibility in bilingual staffing.

Equation (15) can be used to write a condition that determines when a career manager has sufficient flexibility to guarantee criterion b). Since there is a maximum value \( S(d_b) \leq S(d) \), the following condition is proposed

\[
f_b = \frac{S(d_b)}{S(d)} = \frac{\ln(d_b)}{\ln(d)} \geq \alpha,
\]

where \( 0 \leq \alpha \leq 1 \) is a parameter of the model that can be adjusted by the user as needed. The interpretation of the condition is that a career manager will be able to successfully perform a bilingual staffing reassignment that satisfies criterion b) if they have at least a proportion \( \alpha \) of the maximum possible decision making resources. Finally, the minimum value of \( m_b \) that satisfies this inequality, \( m_b^* \), can be used as to determine the target bilingual staffing level,

\[
m_b^* = \min\{m_b | f_b(m_b) \geq \alpha\},
\]

from which it follows that \( M_b^* = m_b^*/\Gamma \). In practice, this computation is performed by brute force, in that increasing values of \( m_b \) are tested against the condition in Equation (16) until the first (smallest) acceptable value is found.

A value of \( \alpha = 0.9 \) was identified by subject matter experts as a good benchmark, since it provides bilingual staffing targets that are appropriate for rank/occupation groups with which they are familiar. This consultation was essential since no past data is available from which a value of \( \alpha \) can be inferred. It might appear as if staffing targets are therefore being chosen by hand. However, the point is that the same standard of \( \alpha = 0.9 \) will be applied to all groups (and career managers), including those for which there was no consultation. It was fixed by considering a small subset of groups, but it will be applied to the entire population, similar to the way that an integration constant is fixed by a boundary condition but applies across the entire domain of the solution. In the future, the process of choosing \( \alpha \) might be refined with data, but it will always provide a standard that can be applied democratically to different groups within the CAF.
As a final technical point, it is worth noting that rounding can be important in practice. For example, if \( N_b = 3 \) and \( \Gamma = 1/4 \) then \( n_b = 3/4 \) is not a whole number. There is no mathematical obstruction to calculating \( d_b \) with this (or any) non-negative input, since the factorials in Equation (12) can be analytically continued with the Gamma function, and non-integer summation bounds can be thought of as upper bounds for the summation variable. However, for this scenario, in practice there are some years when \( n_b = 0 \) and some years where \( n_b = 1 \). So a conservative determination of \( M_b^* \) for this group should use \( n_b = 1 \) as input to ensure that there are enough bilingual members to fill one bilingual position in years when required. So, when \( n_b < 1 \), \( n_b \) is rounded up to ensure that sufficient bilingual resources are available each year. Rounding has a much smaller impact on groups with larger \( n_b \) and is not performed in these cases.

Results

This section presents sample target bilingual staffing levels, or bilingual staffing requirements, as calculated by the model. The model’s output is examined as a function of its various parameters, and the results are explained within the context of career management. The first such results can be found in Fig. 3 which displays bilingual staffing targets, \( M_b^* \), as a function of \( N_b \) for a group of size \( M = 50 \).

![Figure 3](image-url)

**Figure 3.** The parameter dependence of bilingual staffing targets. The two results in red represent the same choice of parameters.

The plot on the left shows how the target number of bilingual members changes as \( \alpha \) is adjusted. The \( \alpha \) parameter is a user-controlled quantity that can be adjusted to change the assumed minimum decision making resources required by career managers. Furthermore, if career managers do not successfully fill bilingual positions when \( \alpha = 0.9 \) then it can be increased to endow them with more resources, i.e., more bilingual members. From this point of view, it is reasonable for the target number of bilingual members to increase with \( \alpha \).

The plot on the right of Fig. 3 shows how bilingual staffing targets change with \( \Gamma \). This quantity measures how quickly positions are reassigned and there are two trends worth noting. The first is the presence of a tail in each distribution as the number of bilingual positions approaches zero. These tails exist because groups with \( \Gamma N_b = n_b < 1 \) bilingual must still have enough bilingual members to fill \( n_b = 1 \) position, as discussed above. So the targets for values of \( N_b < \Gamma^{-1} \) are all the same. The target associated with the tail increases as \( \Gamma \) decreases, which is reasonable, since filling one bilingual position per year requires at least \( \Gamma^{-1} = \tau \) bilingual members.

The other trend is that smaller values of \( \Gamma \) require more bilingual members to staff the same number of bilingual positions, i.e., smaller values of \( \Gamma \) have higher target BSRs. For example, with \( M = 50 \) and \( N_b = 15 \), the model prescribes \( M_b^* = 30 \) for \( \Gamma = 1/3 \) and \( M_b^* = 35 \) for \( \Gamma = 1/5 \). It might seem counterintuitive that two scenarios with the same \( N_b/M \) would have different bilingual requirements. However, from a career management point of view the \( \Gamma = 1/5 \) case is inherently less flexible, on account of its smaller annual numbers.

More precisely, when \( \Gamma = 1/3 \) the career manager must fill \( n_b = 5 \) bilingual positions each year. When \( \Gamma = 1/5 \), then \( n_b = 3 \). So there are fewer positions to fill each year when \( \Gamma = 1/5 \), but a career manager also has fewer positions to work with in this case. The model gives a target \( m_b^* = 10 \) when there are 5 bilingual positions to fill annually, but it does not
give $m_b^* = 6$ when there are 3 bilingual positions to fill annually. Quantitatively, in the first case, $f_b = 0.90$ and in the second case $f_b = 0.85$. Qualitatively, a larger portion of the viable staffing options is removed by a single constraint in a small group. The model compensates for the limitations of a small group by recommending 7 bilingual members per year instead of 6 (or 35 total bilingual members instead of 30) when $\Gamma = 1/5$.

A similar trend can be seen as the size of the group changes. Fig. 4 shows bilingual staffing targets for groups of different sizes. The plot axes are normalized to facilitate the comparison between groups of different sizes.

![Bilingual Staffing Targets for $\alpha=0.9, \Gamma=1/3$](image)

**Figure 4.** The bilingual requirements for groups of different sizes, and the large $M$ limit of bilingual requirements.

The first plot in Fig. 4 shows that target BSRs increase for smaller groups. The reason for this pattern is the same as above: smaller staffing numbers limit a career manager’s flexibility, even when $M$ is the same in the two scenarios.

The right plot in Fig. 4 shows the bilingual requirements for a very large group with $M = 100$. As $M$ is increased, the normalized bilingual requirements converge, and for groups as large as $M > 60$, this curve approximates the bilingual requirements to within five percent. In practice, most groups have $M > 40$ and $N_b > \tau$, and a universal curve can be used to determine bilingual staffing requirements for a given choice of $\alpha$ and $\Gamma$ parameters.

**Limitations**

One of this model’s primary assumptions is that there is one member per position within a group. In practice, it is common for manning requirements to exceed the number of personnel available, so that $M < N$. However, the assumption of $M = N$ is still a good approximation for a number of reasons. The first is that manning levels as low as $M/N = 0.90$ are considered unhealthy and actively remedied through occupation management. So the assumption that $M = N$ is typically correct to within 10%, and the results should be similarly accurate.

Issues of attrition and promotion are also neglected in this analysis. A steady state is assumed where members who attrite are replaced by members who are promoted, and the size of the group is unchanged each year. The effects of attrition and promotion are to cycle more individuals through a given group, which actually makes bilingual staffing easier for career managers by abating career mobility requirements. For example, an important concern is that a shortage of bilingual members would result in those members being placed repeatedly in the same bilingual positions instead of gaining experience from a variety of different positions. If members are frequently moving through ranks, then it is easier to ensure that position assignments are varied, and thereby ensure opportunities for career advancement.

A final consideration that was neglected is the extent of a member’s bilingual capabilities. The CAF does not dichotomously classify members as bilingual or unilingual. There are degrees of second language capabilities, and positions might require superior second language oral skills and only intermediate writing skills. This is not accounted for in the model. However, one approach to this problem is to classify any member with, say, intermediate oral skills as bilingual, and any position with second language requirements as bilingual, and then adopt the model above. This would not ensure that a position with superior second language writing requirements is always filled by a member that has these skills, but the member filling the position would at least have some proficiency in both languages.
Conclusion

A model is presented in this paper that determines target bilingual staffing levels for rank/occupation groups within the CAF, based on the number of members and bilingual positions within the group. The model is especially timely, as the designation of bilingual positions with the CAF is being revisited. The newly designated bilingual positions will have bona fide bilingual requirements, and poor bilingual staffing success rates, which have been a historical problem, will have a meaningful impact on operational capability.

The model is based on the assertion that successful bilingual staffing can only happen efficiently and successfully if members with bilingual capabilities are systematically placed in bilingual positions. This is a departure from the previous assumption that the best route to increasing the bilingual staffing success rate is to increase the bilingual capabilities of the entire CAF. As a result, this model was based entirely on mathematical reasoning, partly because of this new point of view, and also because the restructuring of bilingual positions within the CAF precluded the use of any historical data. Bilingual staffing targets are determined from combinatorial and information theoretic considerations, and the fine tuning of these targets can be performed by the model user through the adjustment of the model’s single parameter, $\alpha$.

There are plans to apply the model before the end of 2016. It should help ensure that second language resources within the CAF are being used efficiently, and follow up studies may be considered in the future to ensure career manager accountability and to confirm the efficacy of these new bilingual staffing targets. Bilingualism within the CAF is an important legal, cultural, financial and operational issue that should hopefully be improved by the implementation of this model.

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