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DOR(CORP) RESEARCH NOTE RN2001/04

CAREER FLOW ANALYSIS OF THE PROPOSED COMBAT ENGINEER OCCUPATION

by

I. A. Collin

June 2001

OTTAWA, CANADA

National Defence Défense nationale

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by

I. A. Collin

Recommended by:

Team Leader,
Personnel Operational
Research Team

Approved by:

Director,
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(Corporate)

OTTAWA, CANADA June 2000

ABSTRACT

In support of the Military Occupational Structure Analysis Re-design and Tailoring initiative, the Director Military Human Resource Requirements requested that the Personnel Operational Research Team investigate the long-term implications of amalgamating two military occupations, Field Engineer and Field Engineer Equipment Operator, into the new occupation of Combat Engineer. This paper provides a career flow assessment of the amalgamated occupation.

It is found that, from a career flow perspective, no significant problems appear to be associated with the amalgamation of these two occupations. Occupational stability, as measured by strength, intake, promotions, releases and experience distributions, is forecast to be acceptable, i.e., not requiring structural change.

RÉSUMÉ

À l'appui du Projet d'analyse, de restructuration et d'adaptation de la structure des groupes professionnels militaires, le Directeur – Besoins en ressources humaines militaires a confié à l'Équipe de recherche opérationnelle (Personnel) la tâche d'étudier les incidences à long terme de la fusion des deux groupes professionnels militaires, Sapeur et Sapeur – Opérateur d'équipement, en un nouveau groupe, Sapeur de combat. Le présent document évalue le cheminement de carrière au sein du nouveau groupe professionnel militaire.

Du point de vue du déroulement de carrière, il appert que la fusion des deux groupes professionnels militaires susmentionnés ne pose aucun problème majeur. La stabilité professionnelle, mesurée en fonction des effectifs, des nouvelles recrues, des promotions, des libérations et de l'expérience, devrait se situer dans les limites acceptables, c.-à-d., ne demandant pas de changement structurel.

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CAREER FLOW ANALYSIS OF THE PROPOSED COMBAT ENGINEER OCCUPATION

I. INTRODUCTION

Background

1. In February of 2001, the Director Military Human Resource Requirements (DMHRR) requested that the Personnel Operational Research Team (PORT) investigate the long-term implications of amalgamating two military occupations, Field Engineer and Field Engineer Equipment Operator, into the new occupation of Combat Engineer. The proposed amalgamation is part of the Military Occupational Structure Analysis Re-design and Tailoring (MOSART) initiative. During Occupational Analysis, the Field Engineer Equipment Operator was judged as no longer sustainable as a separate occupation. Amalgamation would allow greater flexibility in occupational management, and would reduce training overhead. The heavy equipment training of the Field Engineer Equipment Operator would be treated as specialty training for the Combat Engineer.

Aim

2. The aim of this paper is to provide a career flow assessment of the amalgamated occupation. This is accomplished by describing the modelling approach, including fundamental assumptions and the source of input data, and by analysing model results.

Caveats

3. The results of this study were extracted from computerised simulation runs of career flow. They are, therefore, only predictions of the future state of the Combat Engineer occupation, not necessarily a portrait of reality. Future patterns and values of promotion and attrition, which ultimately determine model results, are based on historical promotion and attrition data. At any time, certain factors, such as alternate employment opportunities, perceptions of the military quality of life, and terms of service (TOS) conversion rates, may cause these patterns to change.

4. Although the software from which results were obtained has gained acceptance as the primary predictor in measuring the health of an occupation [1], each model is still

only as valid as its supporting data. For this reason, the reported results should only be used to judge trends and behaviour.

II. METHODOLOGY

The Generic Modelling Environment (GeM)

5. The software employed in modelling the Combat Engineer occupation was the Generic Modelling Environment (GeM) as this is the principal software utility that PORT analysts currently use for Canadian Forces (CF) career flow modelling. GeM is a versatile utility which enables models of each occupation to be constructed. Occupation-specific information, such as TOS conversion rates, maximum intake, and promotion and attrition matrices based on historical data, allow each model to be tailored to an occupation. A combined occupation, as in this case of combining the two Field Engineer occupations, uses weighted averages of such information. These weights are the long-term Preferred Manning Level (PML) at each rank. Models are typically run over a 25-year simulation period, with historical promotion/attrition rates determining future population distributions.

6. The initial model population consists of actual individuals retrieved from the current CF population database. For subsequent years, the model causes the initial population to age and to be released, either according to schedule or voluntarily, following historical attrition data. Releases, in turn, cause promotions to occur according to promotion criteria and historical data. Population movement through retirement, promotion and attrition causes individuals to be created as required within the limits of minimum and maximum intake. These generated individuals also enter the system according to an age distribution and an entry plan (which, for the Field Engineer occupations, are basic and occupational transfer).

7. A GeM career flow model is able to track such information as age, rank, years of service (YOS), time in rank and engagement type for each individual in the model. This information is necessary in creating a realistic model, particularly since promotion and attrition bear a direct relationship to rank and YOS, and retirement is compulsory at a certain age. After a simulation is run, various analyses can be performed on these time-dependent parameters. This study, following the example of Reference 2, provides an overview of significant model results, including charts of strength, intake, release,

promotion and eligibility for promotion, and deviation from PML through time, and population distribution as a function of YOS.

Preferred Manning Level (PML)

8. The source of these numbers and of Trained Effective Strength (TES) is the Projected Status Report (PSR), from DMHRR, dated September 1, 2000. The combined model uses the sum, at each rank, of the PMLs for both occupations, as shown in Table I. This table displays the PMLs as of March 31, for years 2001, 2002 and 2003, and the TES as of March 31, 2001.

TABLE I
PREFERRED MANNING LEVELS

Rank	TES_01	PML_01	PML_02	PML_03
CWO	15	15	15	15
MWO	33	35	36	36
WO	83	93	93	92
Sgt	187	188	186	188
MCpl	139	151	152	152
Cpl/Pte	731	647	648	648
Total	1188	1129	1130	1131

Maximum Intake

9. Maximum intake is the greatest number of recruits allowed to become part of the occupation's TES in one year. It may be governed by School Capacity and the manning requirements determined by either DMHRR or Establishment Changes (EC). The source of School Capacity information is Canadian Forces NCM Production [3]. The source of the DMHRR and EC requirements is NCM Production Comparison (Affiliated with PSR) [4]. For the first two model years, the intake is known to be 107 (in 2001) and 42 (in 2002). For subsequent years, the model maximum intake was first set at 90, the School Capacity for MOC 041 alone. When this proved to be too low, the model was re-run with a maximum intake of 105, which is still below the combined School Capacities (at 122) and either of the requirements of DMHRR (at 108) or EC (at 133). The problem of determining an appropriate value for maximum intake in view of conflicting School Capacities and DMHRR/EC requirements has been discussed in a previous paper [5].

Intake Ratio

10. The Intake Ratio is Basic Recruit, 80%, and Land Occupation Transfer Program (LOTP), 20%. The model creates each recruit individually by choosing a random number and comparing to these fractions.

Terms of Service (TOS) Conversion Rates

11. The source of this information is a document entitled, 2000 NCM Conversion Rates. The numbers for MOC 041 and 042 are identical, so no alteration (involving weighted averages) was required. The length of a continuing engagement (CE) is five years. The numbers offered indefinite period of service (IPS) and CE are shown in Table II.

TABLE II
TOS CONVERSION RATES

Rank	IPS	CE
CWO,MWO	100%	0%
WO	80%	20%
Sgt	60%	40%
MCpl,Cpl	0%	100%

Voluntary Attrition

12. Combined release numbers were divided into combined population numbers to obtain release rates per rank and per YOS, as shown in Table III. Release and population numbers were extracted from the database for years 1982 to 1999, not including the years during which the Forces Reduction Plan (FRP) was in effect.

TABLE III
VOLUNTARY ATTRITION RATE BY YOS

YOS	Pte	Cpl	MCpl	Sgt	WO	MWO	CWO
1	0.05	0.03	0.00	0.00	0.00	0.00	0.00
2	0.15	0.04	0.00	0.00	0.00	0.00	0.00
3	0.08	0.06	0.00	0.00	0.00	0.00	0.00
4	0.09	0.04	0.00	0.00	0.00	0.00	0.00
5	0.12	0.05	0.10	0.00	0.00	0.00	0.00
6	0.00	0.06	0.04	0.00	0.00	0.00	0.00
7	0.00	0.08	0.05	0.06	0.00	0.00	0.00
8	0.00	0.04	0.02	0.01	0.00	0.00	0.00
9	0.00	0.03	0.01	0.02	0.00	0.00	0.00
10	0.00	0.05	0.01	0.00	0.00	0.00	0.00
11	0.00	0.07	0.04	0.02	0.00	0.00	0.00
12	0.00	0.04	0.04	0.01	0.00	0.00	0.00
13	0.00	0.04	0.03	0.03	0.00	0.00	0.00
14	0.00	0.07	0.02	0.00	0.00	0.00	0.00
15	0.00	0.03	0.00	0.02	0.02	0.00	0.00
16	0.00	0.06	0.06	0.03	0.02	0.00	0.00
17	0.00	0.00	0.00	0.01	0.00	0.00	0.00
18	0.00	0.08	0.03	0.00	0.00	0.00	0.00
19	0.00	0.05	0.08	0.14	0.04	0.10	0.00
20	0.00	0.14	0.00	0.20	0.03	0.05	0.00
21	0.00	0.11	0.00	0.11	0.06	0.05	0.00
22	0.00	0.11	0.07	0.06	0.06	0.00	0.14
23	0.00	0.33	0.10	0.08	0.05	0.14	0.11
24	0.00	0.50	0.14	0.14	0.16	0.05	0.17
25	0.00	0.50	0.67	0.24	0.08	0.07	0.00
26	0.00	0.00	0.00	0.11	0.04	0.15	0.07
27	0.00	0.00	0.00	0.25	0.10	0.13	0.20
28	0.00	0.00	1.00	0.27	0.07	0.18	0.06
29	0.00	0.50	0.00	0.36	0.00	0.29	0.00
30	0.00	0.50	0.00	0.33	0.42	0.40	0.06
31	0.00	1.00	0.00	0.50	0.14	0.50	0.00
32	0.00	0.00	0.00	0.50	0.33	0.50	0.10
33	0.00	0.00	0.00	1.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00	0.00	0.67	0.29
35	0.00	0.00	0.00	0.00	0.00	1.00	0.40
36	0.00	0.00	0.00	0.00	1.00	0.00	0.50
37+	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Promotion

13. Promotion ratios from MOC 041 and 042 were combined into overall promotion ratios by calculating weighted averages per rank and per YOS. Each number was weighted by the long-term PML at each rank. These ratios are shown in Table IV.

TABLE IV
PROMOTION RATIO BY YOS

YOS	To Cpl	To MCpl	To Sgt	To WO	To MWO	To CWO
1	0.003	0.001	0.001	0.001	0.001	0.001
2	0.086	0.001	0.001	0.001	0.001	0.001
3	0.094	0.001	0.001	0.001	0.001	0.001
4	0.100	0.001	0.001	0.001	0.001	0.001
5	0.152	0.007	0.001	0.001	0.001	0.001
6	0.126	0.014	0.001	0.001	0.001	0.001
7	0.084	0.103	0.001	0.001	0.001	0.001
8	0.075	0.122	0.017	0.001	0.001	0.001
9	0.088	0.240	0.075	0.001	0.001	0.001
10	0.046	0.152	0.161	0.001	0.001	0.001
11	0.029	0.115	0.161	0.001	0.001	0.001
12	0.006	0.074	0.127	0.023	0.001	0.001
13	0.006	0.027	0.101	0.059	0.001	0.001
14	0.015	0.007	0.059	0.125	0.001	0.001
15	0.003	0.014	0.069	0.085	0.117	0.001
16	0.003	0.063	0.037	0.161	0.001	0.001
17	0.015	0.018	0.063	0.116	0.182	0.001
18	0.009	0.006	0.032	0.151	0.121	0.001
19	0.009	0.012	0.027	0.096	0.121	0.001
20	0.015	0.001	0.016	0.035	0.184	0.076
21	0.006	0.001	0.006	0.036	0.031	0.076
22	0.003	0.001	0.006	0.027	0.063	0.076
23	0.003	0.001	0.006	0.036	0.031	0.076
24	0.006	0.001	0.011	0.001	0.001	0.076
25	0.001	0.001	0.001	0.012	0.001	0.076
26	0.001	0.001	0.001	0.012	0.058	0.218
27	0.003	0.001	0.006	0.001	0.001	0.076
28	0.001	0.001	0.001	0.001	0.001	0.076
29	0.001	0.001	0.001	0.001	0.031	0.076
30	0.001	0.001	0.001	0.001	0.031	0.065
31+	0.001	0.001	0.001	0.001	0.001	0.001

III. MODELLING RESULTS

Deviation from PML

14. Two scenarios of forecast deviation from PML are shown. Figure 1 corresponds to a long-term maximum intake of 90, and Figure 2 corresponds to a long-term maximum intake of 105. Although model year 1 represents year 2001, the numbers in year 1 may not be entirely accurate since the initial population database, dating back to December 1999, is updated through calibration. (Calibration is done by setting the PML goal of year 0 to the TES of year 0, then setting the PML goal of year 1 to the PML of year 1.) Figure 1 shows a growing PML deficit at the ranks of Corporal and Private, with little sign of improvement by the end of the 25-year simulation period. (The ranks of Corporal and Private are combined in this graph because, although the model treats these two ranks separately, they are grouped in certain output. In this case, they are grouped in order to perform a comparison with the PSR numbers, which show a combined total of Corporals and Privates.) Therefore, it can be seen that a maximum intake of 90 is insufficient in sustaining the occupation. Figure 2 shows a more acceptable deviation from PML, and all subsequent results derive from this model, i.e., with a maximum intake of 105. As in Figure 1, the only shortages in Figure 2 occur at the ranks of Corporal and Private.

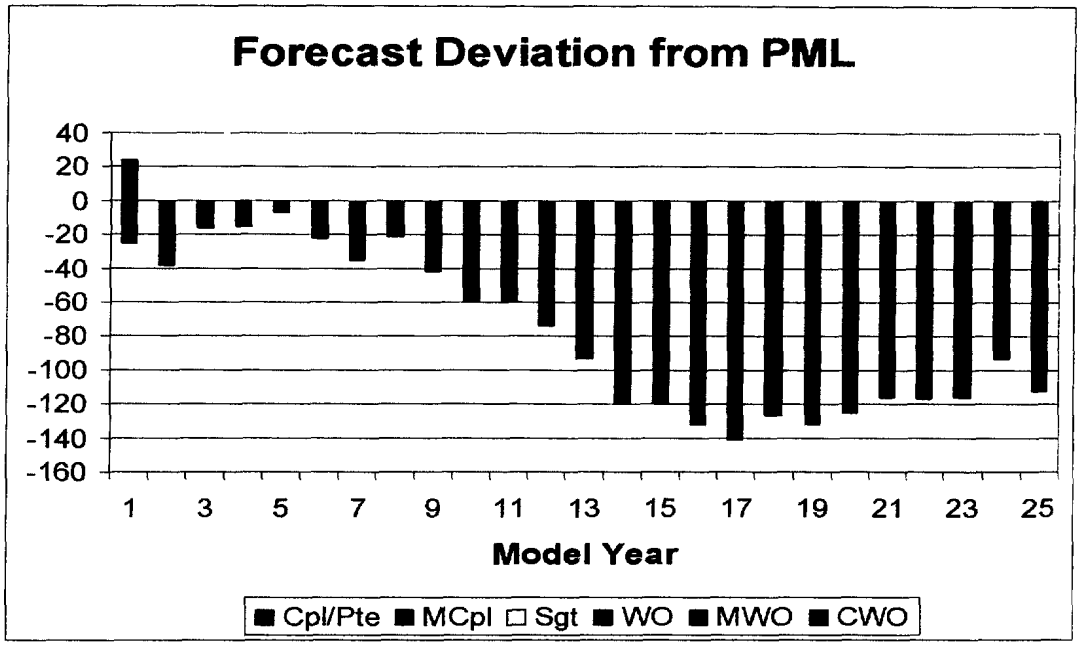

Figure 1: Forecast Deviation from PML, Maximum Intake = 90

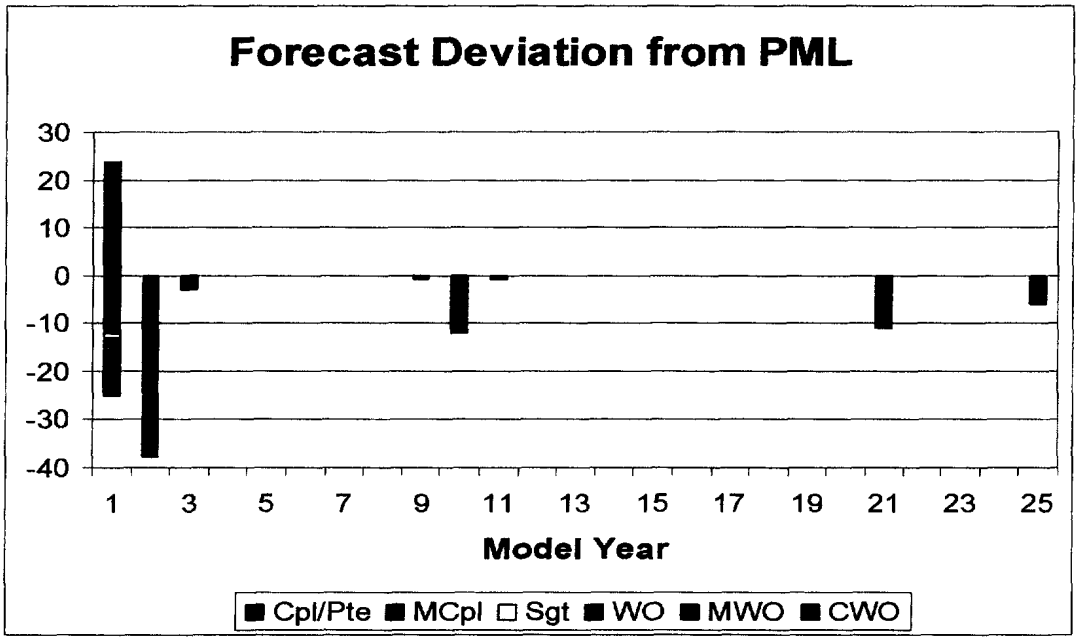

Figure 2: Forecast Deviation from PML, Maximum Intake = 105

Strength by Rank

15. The forecast strength for each model year and each rank is shown in Figure 3. As observed in Figure 2, the population is very stable throughout the modelling period, with only slight shortages occurring at the ranks of Corporal and Private.

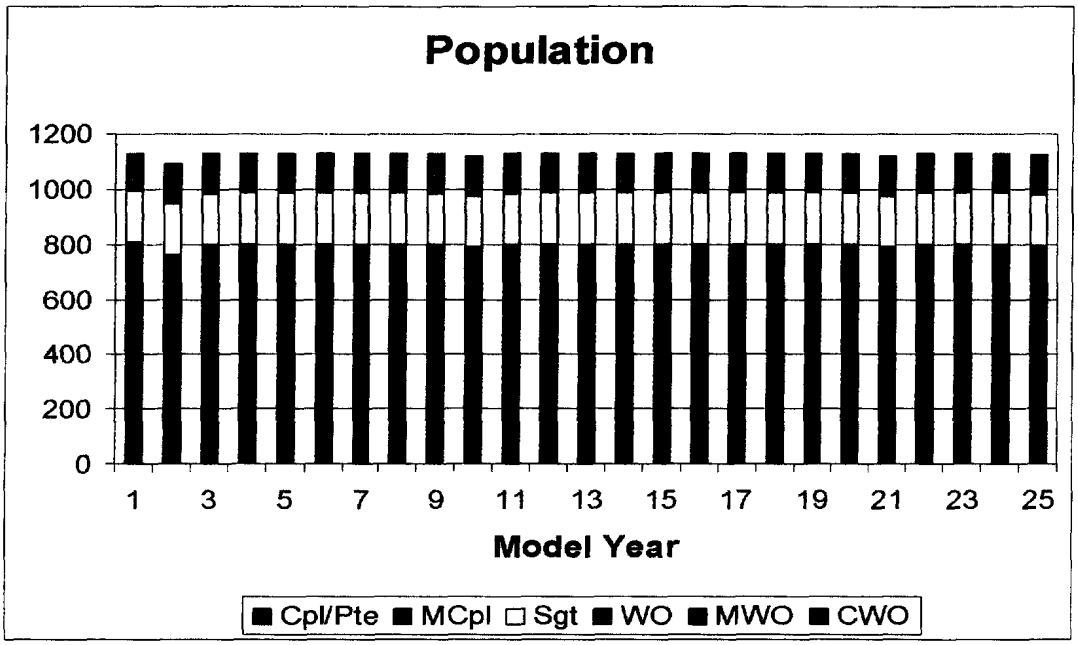

Figure 3: Forecast Strength by Rank

Intake

16. Forecast annual intake is shown in Figure 4. As previously stated, the intake ratio is 80% Basic Recruit and 20% LOTP, and the maximum intake is 105. The comparison between Figures 1 and 2 shows the great effect of intake on deviation from PML. It is preferable that annual intake not fluctuate too much, although model intake is driven by attrition, which can vary from year to year, depending on the numbers in each YOS group, rank and age group. The average intake from years 3 to 25 is approximately 99, with 79 Basic Recruits and 20 LOTP, and the standard deviation is 7. The years for which intake is at the imposed maximum often correspond to years of PML shortfall (Figure 2).

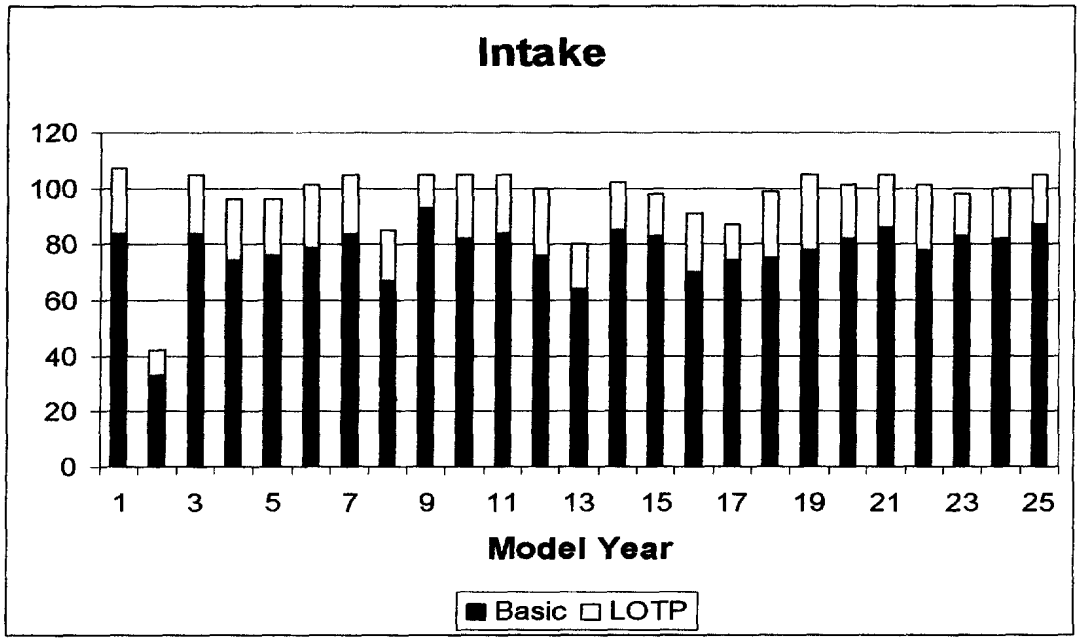

Figure 4: Forecast Intake

Promotions by Rank

17. Figure 5 presents forecast promotions to each rank. Low variability in promotion rates is thought to be desirable in maintaining experience levels and morale within each rank. In this case, in terms of numbers, the greatest variability is found in the rate of promotions to Corporal, with 45 promotions on average per year (after year 2) and a standard deviation of 11. Promotion variability, again, in terms of numbers rather than fractions of average promotion rates, decreases as rank increases, as shown in Table V. (The numbers in this table have been rounded to the nearest whole number.)

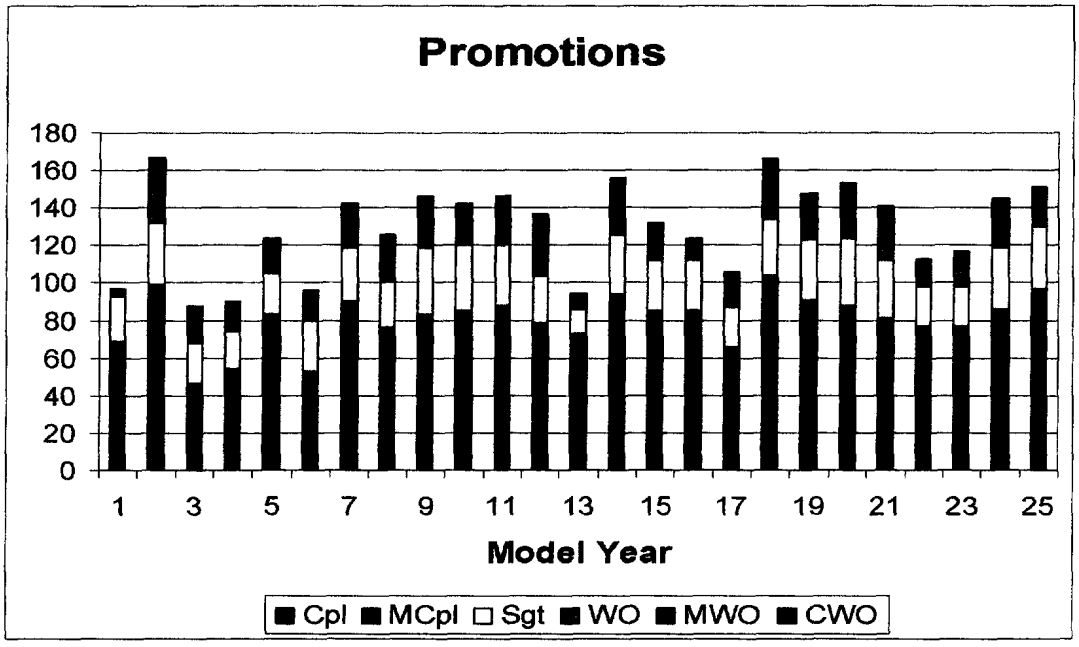

Figure 5: Forecast Promotions by Rank

TABLE V
FORECAST AVERAGE ANNUAL PROMOTIONS

	Cpl	MCpl	Sgt	WO	MWO	CWO
Average	45	35	27	14	6	2
Std. Dev.	11	7	6	4	2	1

Promotions to Master Corporal and the Ratio of Eligibility to Promotions

18. Because Figure 2 showed that the only shortages are expected to occur at the ranks of Corporal and Private, forecast promotions to Master Corporal should be examined. Figure 6 shows that there is no lack of Corporals eligible for promotion to Master Corporal, as compared to the number promoted. The average and minimum ratios of the number eligible to the number promoted to each rank (after year 2) are shown in Table VI.

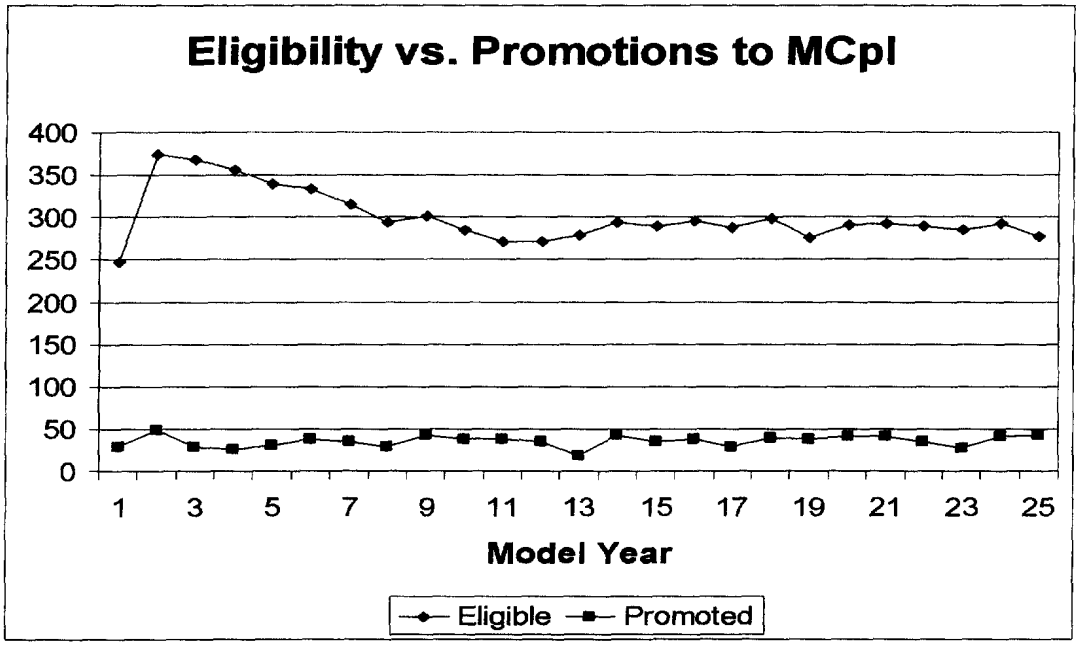

Figure 6: Forecast Eligibility vs. Promotion to MCpl

TABLE VI
FORECAST RATIO OF ELIGIBILITY TO PROMOTIONS

	MCpl	Sgt	WO	MWO	CWO
Average	9.03	4.30	9.83	10.95	14.11
Minimum	6.47	3.06	5.89	4.80	5.00

Releases

19. Figure 7 presents forecast releases by reason, including voluntary, scheduled (or end of engagement) and compulsory retirement age (CRA). After year 3, the numbers are fairly constant overall. The exception occurs in the number of CRA releases, which are expected to be 0 or 1 until year 17, then increase to the range of 1 to 4. Table VII shows average annual release numbers and standard deviation from years 3 to 25. As a fraction of the total population (using the long-term PML of 1131), annual voluntary attrition would be 7.7% and total attrition would be 8.6%.

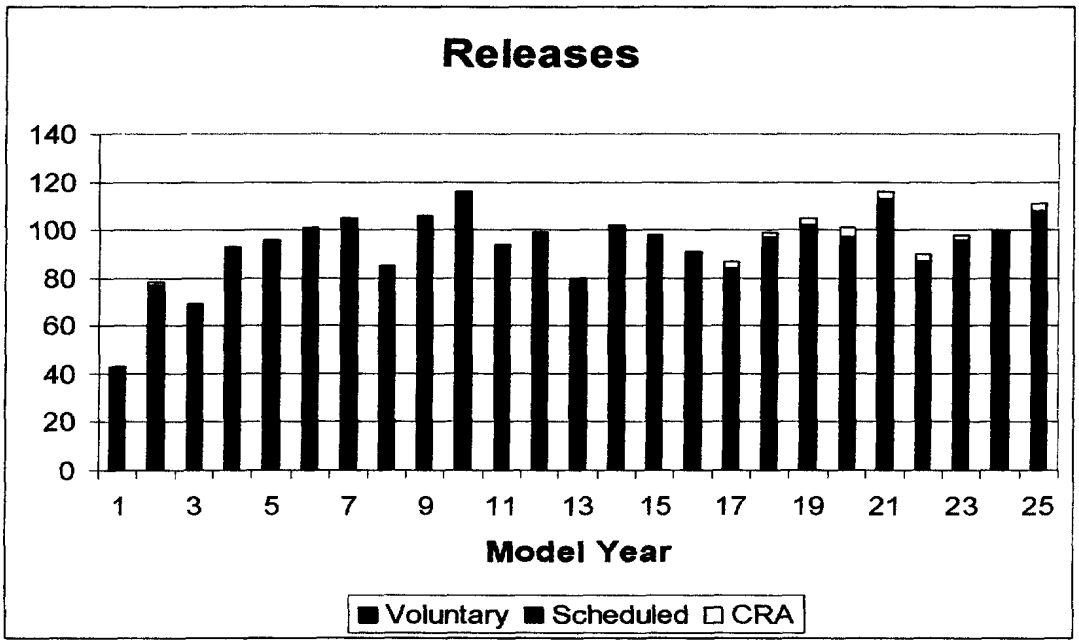

Figure 7: Forecast Releases

TABLE VII
FORECAST RELEASE AVERAGES

	Voluntary	Scheduled	CRA	Overall
Average	87	9	1	97
Std.Dev.	11	5	1	11

Population Distributions by Years of Service (YOS)

20. Figures 8 through 12 show forecast population distributions through time as a function of YOS. The results of model year 2 (or actual year 2002) are presented in Figure 8, followed by model year 7 results in Figure 9, and so on, with a time lapse of five years between each figure, up to Figure 12 (model year 22). Figure 8 shows a peak of Corporals/Privates at 6 YOS and a gap at 9 to 10 YOS. This reflects the recruiting pattern during and immediately after the years for which the FRP was in effect. There is a sizeable group of Corporals between 11 and 21 YOS, which coincides with the majority of Sergeants. This may be a dissatisfying factor among the 11-21 YOS Corporals, who are beyond the "promotion zone".

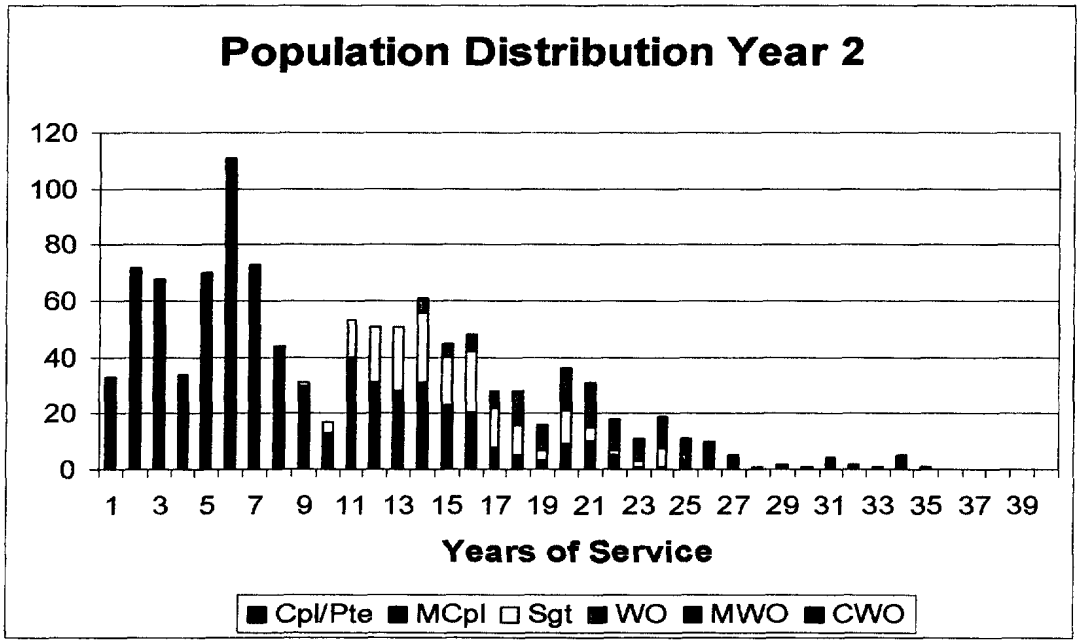

Figure 8: Forecast Population Distribution, 2002

21. The peaks and valleys of Figure 8 can be traced through the later population distributions in Figures 9 through 12. Observe the peak at 11 YOS in Figure 9, 16 YOS in Figure 10 and 21 YOS in Figure 11, all following on the 6 YOS peak in Figure 8. Even Figure 12, at 26 YOS, gives evidence of this group of recruits. Figure 9 shows a less variable population in the range of 1 to 5 YOS, but many of the 11-16 YOS Corporals of Figure 8 are now Corporals with 16 to 21 YOS. Some of these Corporals remain in the CF for another five years, to become 21-26 YOS Corporals in Figure 10.

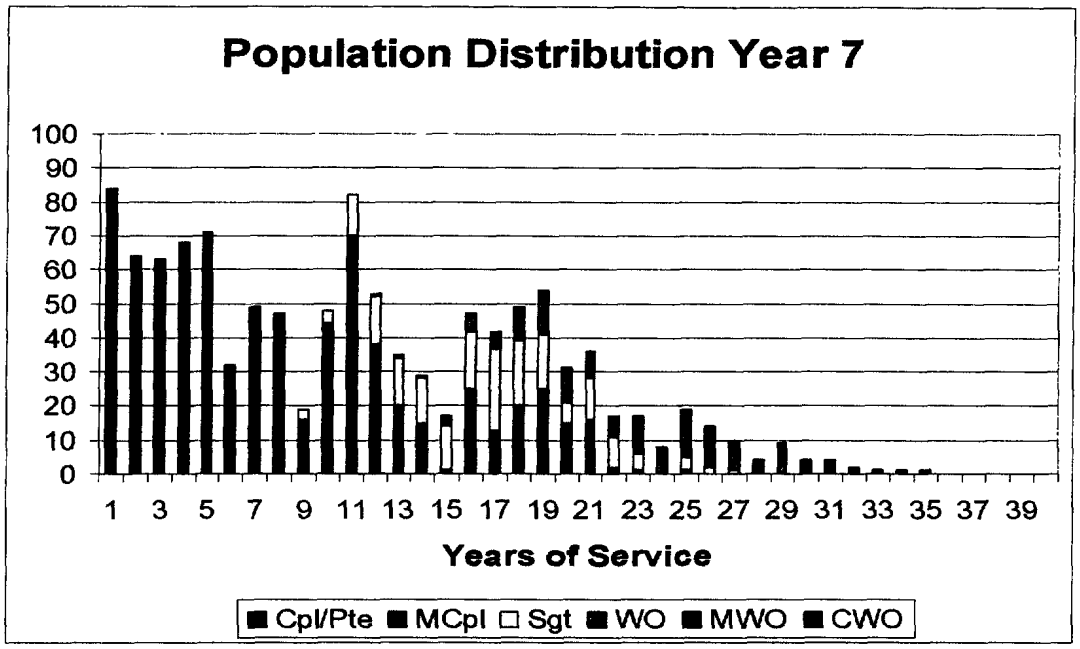

Figure 9: Forecast Population Distribution, 2007

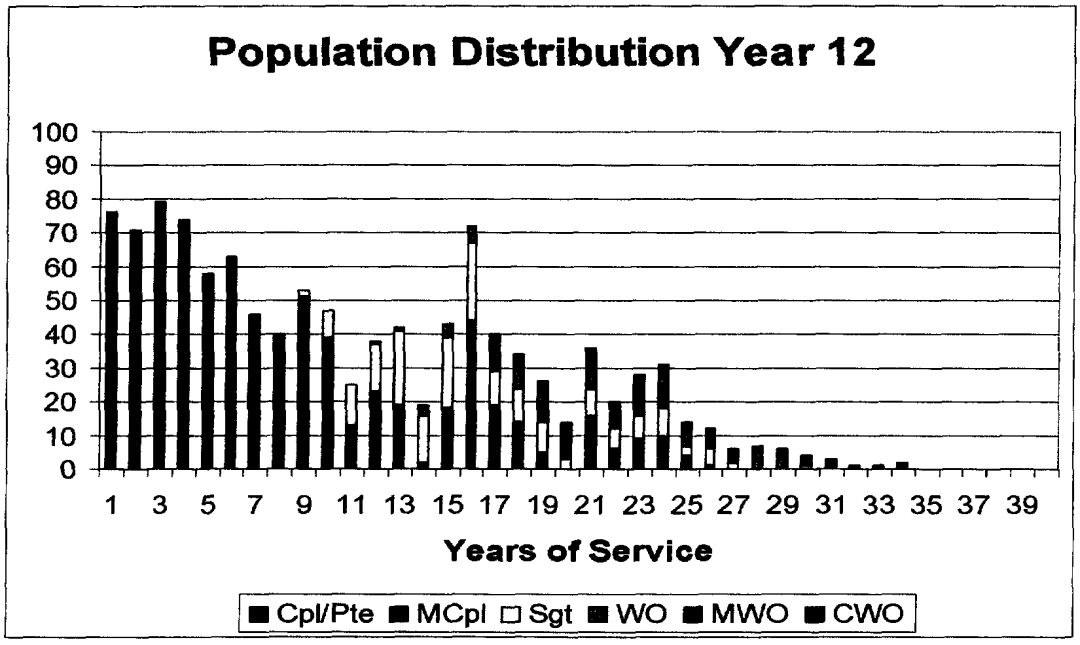

Figure 10: Forecast Population Distribution, 2012

22. Figures 11 and 12 show that the population distribution is expected to assume a more desirable profile as a result of years of systematic recruiting.

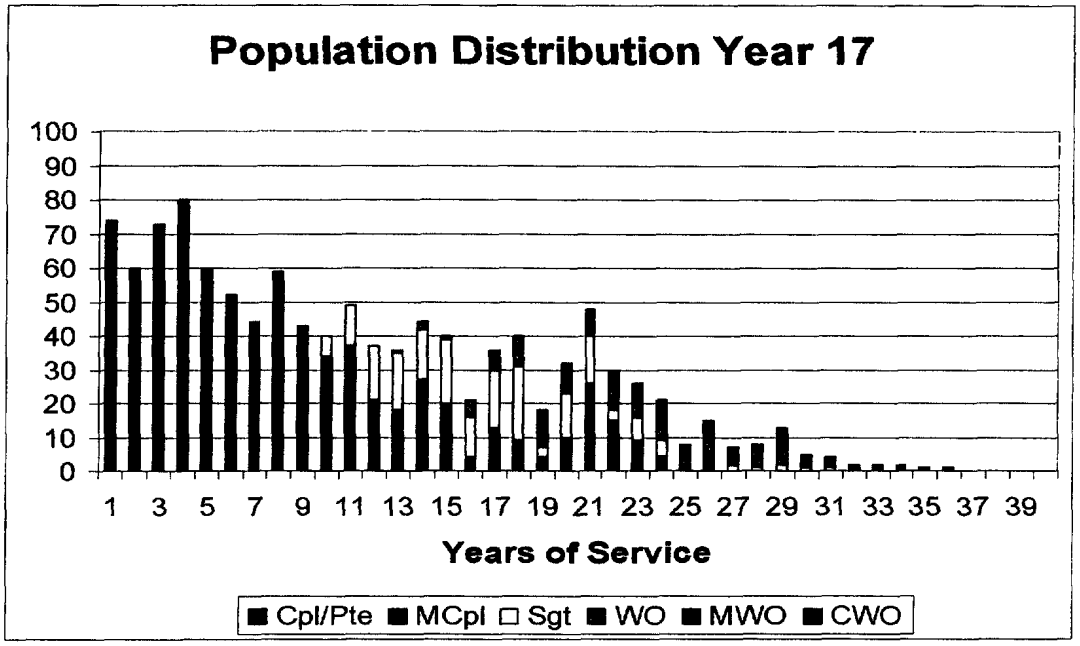

Figure 11: Forecast Population Distribution, 2017

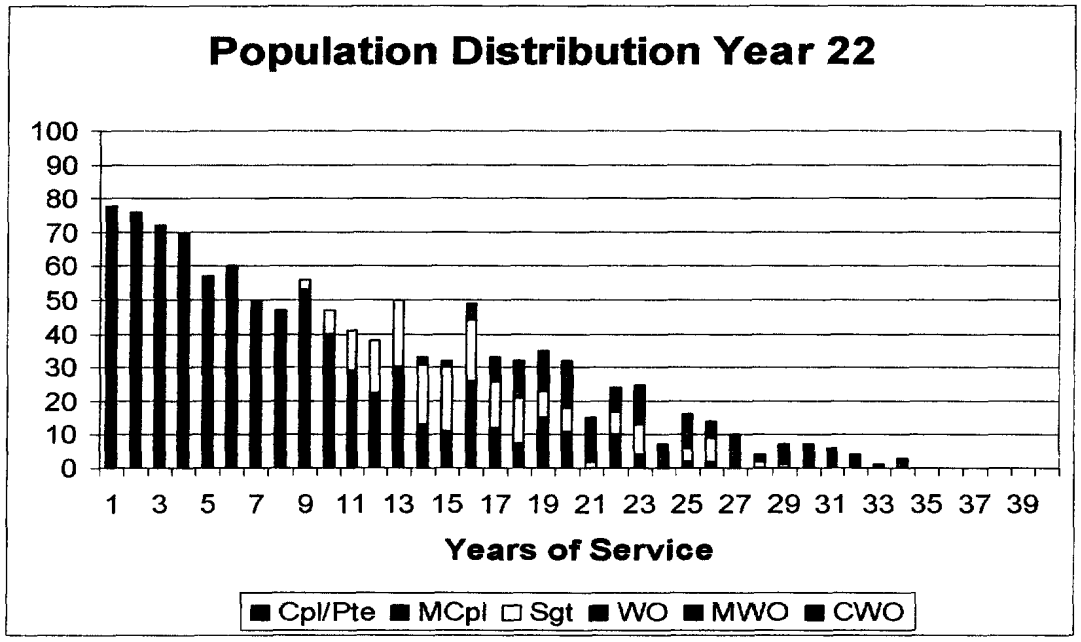

Figure 12: Forecast Population Distribution, 2022

IV. SUMMARY AND CONCLUSIONS

23. Using the stated modelling assumptions, there do not appear to be any significant career flow problems associated with the amalgamation of the Field Engineer and Field Engineer Equipment Operator occupations into the Combat Engineer occupation.

24. With a maximum intake of 105, the population as a whole should be stable and close to PML, with the only shortages expected to occur in the ranks of Corporal and Private. The average annual intake (after 2002) should be approximately 99, with a standard deviation of approximately 7. These numbers are considered to be consistent with a stable occupation.

25. The variability in promotions is expected to be greatest for promotion to Corporal, and this number is limited not by a fixed number of positions, but by intake. In terms of numbers, the variability is expected to be smaller for promotion to all other ranks and should be acceptable.

26. Despite some expected shortages at the rank of Corporal, there should not be any shortage in the number of Corporals who are eligible for promotion to Master Corporal. The average ratios of eligibility to promotion to all other ranks should be within acceptable limits [6].

27. Most releases (approximately 90%) are expected to be voluntary, with fewer scheduled releases (at approximately 9%) and even fewer CRA (at approximately 1%). CRA releases are expected to increase at model year 17. The variability in voluntary release rate should not be problematic for the amalgamated occupation.

28. Although the Field Engineer occupations have been very well managed, the effects of some uneven recruiting in past years can be seen 20 years into the future. With time, systematic recruiting should improve the shape of the population distribution. Variations in voluntary attrition, promotion and intake are more dependent on current population characteristics than on changes as the result of occupational amalgamation.

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In support of the Military Occupational Structure Analysis Re-design and Tailoring initiative, the Director Military Human Resource Requirements requested that the Personnel Operational Research Team investigate the long-term implications of amalgamating two military occupations, Field Engineer and Field Engineer Equipment Operator, into the new occupation of Combat Engineer. This paper provides a career flow assessment of the amalgamated occupation.

It is found that, from a career flow perspective, no significant problems appear to be associated with the amalgamation of these two occupations. Occupational stability, as measured by strength, intake, promotions, releases and experience distributions, is forecast to be acceptable, i.e., not requiring structural change.

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