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Canadian Air Reserves, Readiness and Learning Theory

by

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OPERATIONAL RESEARCH AND ANALYSIS

DIRECTORATE OF SOCIAL AND ECONOMIC ANALYSIS RESEARCH NOTE 3/93

Canadian Air Reserves, Readiness and Learning Theory

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ABSTRACT

This note discusses the readiness issue pertaining to the Canadian Air Reserves. Factors affecting the reservists' level of preparedness and/or readiness are examined. Under the hypothesis that reservists do not train as much as their active counterpart, the feasibility of using learning theory to estimate the cushion of time for the Reserves to complete mobilization and training to be ready for deployment is explored.

RÉSUMÉ ANALYTIQUE

Le document porte sur l'état de préparation de la Réserve aérienne au Canada. On y examine les facteurs qui influent sur le niveau de préparation des réservistes. En partant de l'hypothèse que ces derniers ne s'entraînent pas autant que leurs homologues du service actif, on étudie la possibilité d'évaluer, au moyen de la théorie de l'apprentissage, le temps qu'il faudrait pour mener à bien la mobilisation et l'instruction des réservistes pour qu'ils soient aptes à être déployés.

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CANADIAN AIR RESERVES, READINESS AND LEARNING THEORY*[1]

INTRODUCTION

1. In 1987, the Department of National Defence enunciated the "Total Force" concept in the Defence White Paper.

> 'The Total Force establishment of the Canadian Forces is comprised of Regular and Reserve components, none of which are subservient to, or in support of one another. Units in the Total Force can be comprised of any mix of Regular and Reserve Force personnel and equipment.'
>
> Vice Chief of Defence Staff

The intent of the Total Force policy is to make maximum use of the Reserve components in order to reduce defence expenditures significantly and permanently while at the same time to ensure that national military capability remained adequate to support national policy objectives.

2. Since publication of the White Paper, the ending of the Cold War has led to worldwide changes in defence thinking as well as demands for reductions in expenditures. The "Total Force" concept has continued to be attractive, as potentially contributing to reduced expenditures while reinforcing national military capability.

3. Now that the Department has announced increased reliance on the Reserve component, the latter will shoulder a greatly increased responsibility (and one unprecedented in the last four decades) for protecting the nation's security interests. In this context, the actual design of components of the "Total Force" raises many analytical questions about how to measure military capabilities of reserves and regulars and their training requirements.

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[1] *This work was sponsored by PD ARM and carried out under ORA/DSEA Project 45742.

4. Unfortunately, the assessments of military capability are among the most difficult problems facing military analysts [1]. Military capability - the ability to achieve a specific objective, for example to destroy a target set - depends on measurable resources such as the number of soldiers, weapons, etc. and also on nonmeasurable intangibles such as leadership, morale as well as the cohesiveness of the unit. Lacking an acceptable methodology for measuring military capability, a widely used surrogate has been military readiness. It is defined as the ability of a given force, at a given time to deliver for a specified period, the military response for which its war establishment was defined [1].

5. Military readiness is typically measured in five resource categories: personnel strength, individual skill qualification, equipment level, equipment condition, and unit training [1]. Each category is assigned a condition rating, ranging from "fully combat ready" to "not combat ready", depending on the percent of the unit's wartime requirements for people and equipment and the estimated training time required for a unit to reach fully trained status. The unit is also assigned an overall rating, usually the lowest of the category ratings, but subject to adjustment by the unit commander.

6. This evaluation system has many shortcomings. First, it measures inputs rather than outputs. Second, the system provides a snapshot in time rather than an average condition, since not all units are required to make reports and even those that are, do so periodically. Finally, the training - condition rating is largely subjective, depending on the judgement of the unit commander. Despite such limitations, the above system provides a formidable means to measure readiness.

7. In this note, we will discuss the readiness issue pertaining to the Canadian Air Reserves. We will examine factors affecting the reservists' level of preparedness and/or readiness. Under the hypothesis that reservists do not train as much as their active counterpart, we will also comment on the feasibility of using learning theory to investigate the cushion of time for the Reserves to complete mobilization and training to be ready for deployment.

FACTORS AFFECTING AIR RESERVES' READINESS

8. It is generally accepted that the important means for attaining a high state of reservists' readiness depend on the convergence of training time, equipment, individual trade skills and unit training.

9. Under the Canadian Total Force policy, joint training between the two components of the Armed Forces is encouraged and promoted wherever feasible. It is expected that the Regular Force training cycle will be adjusted to provide more opportunities for the Regular Force and Reserves to train together [2]. In addition, within appropriate training scenarios, equipments will be shared between the Regular and Reserve Forces. For example, in the exercise EX ON GUARD 90, some 11,000 reservists trained alongside the Regular Force; exercise RV 92 saw some 1,000 reservists involved. In the Air Force environment, there are currently 23 locations where Air reservists are working in tandem with members of the Regular Force, trained to the same standard and using the same equipment [3]. Indeed, the collective training and equipment sharing between the Regular and Reserves within the Air component of the Total Force have gone beyond the training scenarios to become realities. Air Reserves were employed as pilots and support staff in 10 Tactical Air Group helicopter peacekeeping operations in the Middle East and Central America [3]. At CFB Shearwater, the Air Reserve played a major part in the

extensive refit programme for the Sea King helicopters in the Gulf, and Air Reserves flew air transport missions to the Gulf area and participated in the support of these operations [3].

10. It is observed that because of the nature of the Air components missions which permits a greater concentration on individual training and proficiency, the Air Reserves have found it easier to maintain their proficiency than the Army Reserves (even though Air units need to maintain and operate sophisticated equipment which would appear to be more demanding.) First, Air Reserves units are normally co-located with their active units. As a result, the logistics, maintenance and administrative support all benefit from the physical setup. Also, the mobility of the Air flying units allows them to use distant training facilities, so realistic training and/or execution of taskings can be carried out more readily. (On the other hand, Army Reserves, such as infantry units, find it difficult to maintain their proficiency because they need larger maneuver exercises to simulate land combat activity.)

11. Regular Forces, by definition, have significantly more training time available each year than do reservists. This greater opportunity to train allows active units to be more effective and in general results in a greater initial capability. These disparate peacetime capabilities to perform emergency missions are reflected in different response times for Reserves and Regular Forces.

12. Thus far, we have argued that among the factors influencing the Air Reserves' readiness, the key parameter hampering their level of preparedness has been the lack of training time. The level of preparedness or the degree of responsiveness for the Air Reserves are then based on the assumption that sufficient time between mobilization and deployment would be available to train them up to higher

standards, if necessary. The challenge for the determination of Air reservists' readiness is reduced to the estimation of the amount of training time necessary to train them up to higher proficiency. The latter issue is notoriously difficult to predict on account of the wide spectrum of activities involved in training exercises. Nonetheless, it is known that for certain families of military trades (notably those which involve routine 'motor skills'), denoted herein by $\mathcal{U}$, the training missions often involve doing tasks more repetitive than other trades. Examples are load masters, supply technicians, transport aircrews, etc. The aim of this note is to discuss the relevance of employing learning theory [4] to shed some light on the determination of the cushion of time to complete training for reservists in $\mathcal{U}$, should the need arise. (At this stage, the theory can only be applied to the study of training effectiveness for reservists in preparation for a single task.)

LEARNING THEORY

13. It is common knowledge that the first time a person does something, it takes a lot longer to complete than after he or she has had some practice. The study of this behaviour has been pursued extensively by social scientists and industrial engineers in learning theory [4]. It relates to how people learn by doing a task repetitively. One notable application of learning theory will be to evaluate the amount of training time required to do a task repetitively so as to attain a certain level of proficiency, say with task duration S hours, (the derivation of the formula can be found in the Appendix),

$$\text{Training time} = \frac{K\{X^{1-A} - 1\}}{1 - A} - XS \qquad (1)$$

where K = time duration required to do the task initially (i.e. time for the first cycle); given $S < K$;

X = a finite number, frequency of performing the task repetitively (number of cycles) so as to achieve the specified proficiency level with task duration S, X is given by antilog[-log(S/K)/A];

A = a parameter depending on the rate of learning. For example, if a task is repeated twice and its duration for completion is given by a fixed percentage (depending on the learning rate) of the initial task duration, say 90%. Then A can be calculated as -log(90%)/log2, or 0.1520.

The training time (eq.(1)) as a result of learning is depicted in Fig.1.

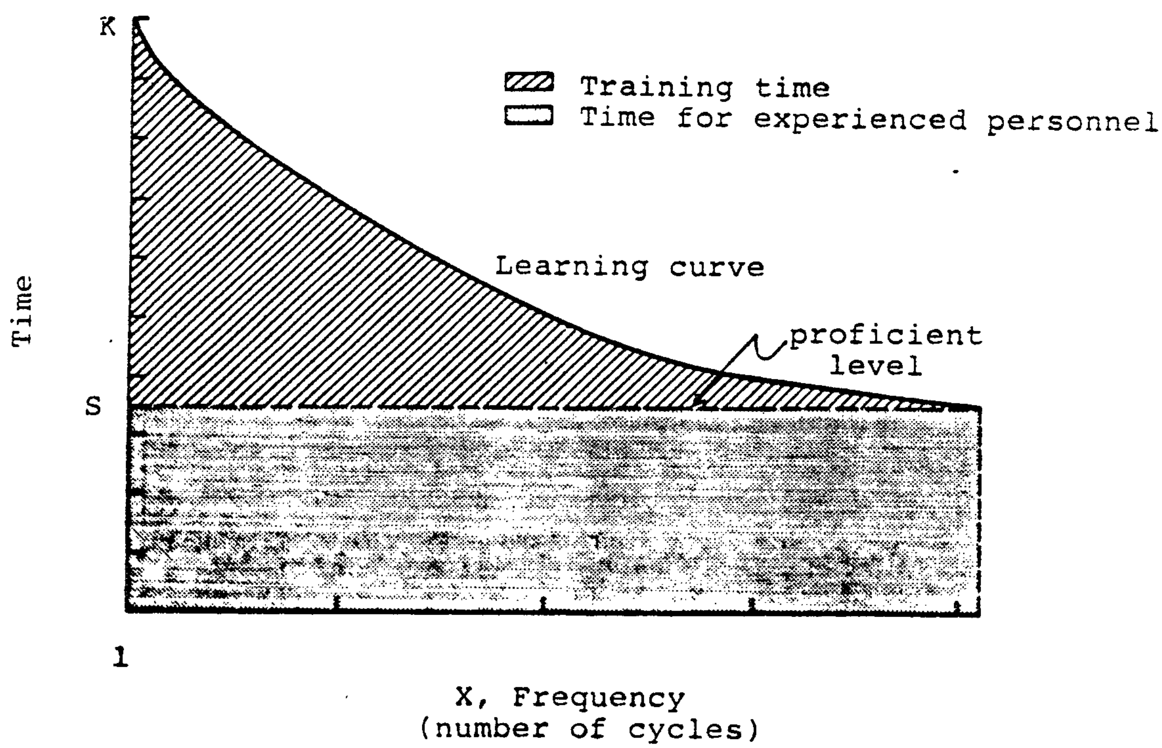

Fig. 1 - Training under Learning

Next, we let

W = the amount of training time required by the reservist (who is in $\mathcal{U}$) to attain the specified proficiency;

Y = the training time required to attain the specified proficiency by a hypothetical reservist, whose task is wholly 100% repetitive. The value for Y is evaluated by eq.(1).

By the nature of the definitions, it is conceivable that W is greater than Y. Thus eq.(1) can be used to establish the lower bound for the training time required by the reservist in $\mathcal{U}$ and the tightness of the bound is directly proportional to the degree of repetitiveness of the training task.

14. In the derivation of eq.(1), it is assumed that when reservists are required to complete training and be ready for deployment, the reservists' training time will then be regarded as continuous and without interruptions. That is, the reservist will not stop for any significant amount or period of time for breaks and the reservist will not forget what he or she has learned as a result of having a break (known as 'remission'). On the other hand, eq.(1) can easily be revised to include remission, where the amount of remission is a function of where the reservist is on the learning curve when the break occurs. Details on the regression in the accumulated knowledge is documented in detail in [4].

EXAMPLE SOLUTIONS

15. As an example consider the load master in the transport aircrew. The primary task duties of load masters include load planning and aircraft loading. The latter encompasses

weight and balance checks for the aircraft. The job nature of aircraft loading can be regarded as repetitive.

16. It is given that the monthly flying rate (MFR) of Regular Force load masters is 38 hours. Now, suppose the proficiency level for the Regular Force to load an aircraft is measured by the speed of loading, say "S" hours. Our aim is to estimate the cushion of training time required by Air Reserve load masters to reach a level of S hours, should the need arise. The situation is described in Fig.2 where we are interested in the estimation of the time between deployment and the time in acquiring the level of proficiency S. Assume the reserves have a MFR of 20 hours. Accordingly to eq.(1), reserves load masters will take no less than 9.98S hours in order to train to the same proficiency as the Regular Force counterpart. (Here we are assuming that the initial task duration for the Air reservist is (38/20)S hours and A equals 0.1520.) For the sake of this demonstration, let S be 10 hours, then reserve load masters will require a minimum of 99.8 hours to complete the training. On the other hand, assume the Reserves will be deemed proficient if the task duration is 1.2S hours. Then the time required to complete the training for mobilization will be no less than 6.38S hours or 63.8 hours.

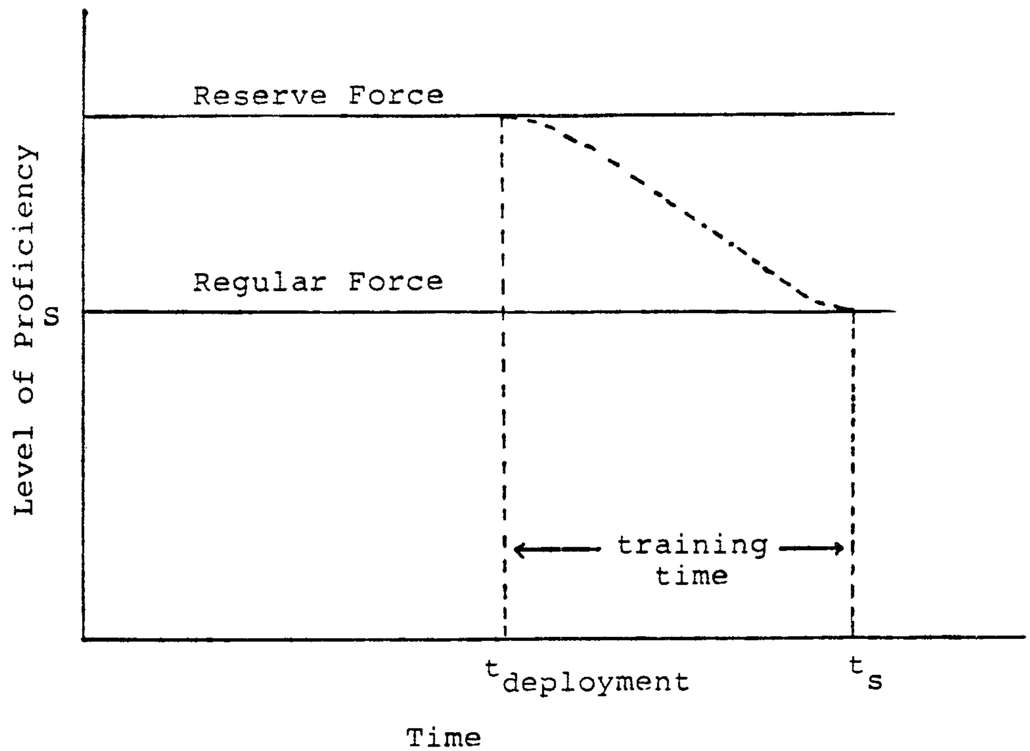

Fig. 2 - Graphical Display of training time for reservists

CONCLUSION

17. In this note, we have proposed an approach to study the training effectiveness of reservists (whose primary duties only involve routine 'motor skills') in preparing for a single task. The study is part of a broad study on the 'Assessment of the Cost of Reserve Personnel' currently conducted for the Canadian Forces. The findings of the study will hopefully assist military planners in determining the merits of various Air Reserve Force manning strategies (subject to specified constraints). For example, the result of this note will provide input data to examine the impact of selective recruiting of reserve members with pre-enrollment skill levels (which affect the value of K in eq.(1)) on training costs.

18. Admittedly, our approach of using learning theory (eq.(1)) to shed some light on the quantification of the reservists' degree of responsiveness is highly constrained by the stringent assumption that the task is to be performed repetitively. In addition, the task duration by a Regular Force member is often difficult to quantify. It is thus reasonable to conclude that at best, the above thoughts on the estimation of the cushion of time required by Air reservists to complete training is a rudimentary approach. It should not be construed as a means to replace empirical measurements. Another limitation of our approach is that it is only applicable to the study of Air Reserves. For example, the cohesiveness provided by unit training, a key parameter affecting the readiness of the Army and Navy, is not being modelled in the learning curve equation. However, because assumptions of the approach are made explicit and causes and effects are related, it can nonetheless prove more useful than hunches and intuition.

19. Currently, research effort has been expended on the validation of the model. Does it provide reasonable projections on training effectiveness? In addition, effort has also been devoted to the generalization of the concept of learning theory to the estimation of training time for reservists in preparing for more than one task. The findings will be reported in subsequent papers.

APPENDIX

20. The behaviour of how people learn by doing a task repetitively can be expressed by the following simple equation [4],

$$Y = KX^{-A} \qquad (2)$$

where K = time duration required to do the task initially (i.e. time for the first cycle);

X = frequency (number of cycles) of performing the task repetitively;

Y = time duration (time per cycle) to complete the task;

A = a parameter (constant) depending on the learning rate.

The key concept expressed by this equation is that every time the frequency of the task is doubled, the duration it takes to complete the task will be decreased by a fixed percentage given by the learning rate LR (a typical value for LR is 90%). By the above description, we can easily determine the value of A by simply solving

$$LR = 2^{-A} \quad \text{or} \quad A = -\log(LR)/\log(2).$$

Utilizing learning theory in our context, the learning curve equation for reservists (in $\mathfrak{U}$) is expressed by the following

$$Y = \begin{cases} KX^{-A} & X \leq X_0 \\ S & X > X_0 \end{cases} \qquad (3)$$

where S = time duration to acquire the Regular Force level of proficiency;

$$X_0 = \text{antilog}[-\log(S/K)/A].$$

Eq.(3) simply states that there will be no improvement on the task time beyond a certain threshold of cycles in repeating the task. The total time it takes to attain the level of proficiency S hours, is,

$$C = \int_1^X KZ^{-A}\,dZ$$

or after integration, C is given by

$$C = \frac{K\{X^{1-A} - 1\}}{1 - A}$$

Since the total time taken by the learning process on performing the task repetitively would be C time units (in Fig.1, it is represented by the area under the learning curve), and the time duration to do the tasking if it were performed by the experienced person would be XS, the training time (see Fig.1) would then be (C - XS) or eq.(1).

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