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THE USE OF OA IN A TRAINING SYSTEM COEIA

Dr A J Dunlop

Directorate of Science(Land)

MoD Main Building
Room 3354
Whitehall
LONDON
SW1A 2HB

0171-218-7206

AIM

1. The aim of this paper is to present a case study of the use of Operational Analysis to support the procurement of a training system. The approach used is believed to be novel and has been favourably received by the MoD's approval system; it is hoped that it will be of interest to the Operational Analysis community.

SCOPE AND ACKNOWLEDGEMENTS

2. This paper provides an overview of the Combined Operational Effectiveness and Investment Appraisal (COEIA) study carried out in support of the UK's Combined Arms Tactical Trainer (CATT). In order to avoid commercially sensitive information, all data and graphs have been 'sanitised'. The axes of graphs do not necessarily start at zero and the scales are not necessarily linear.

3. The main topics covered will be:

   a. Why introduce a new methodology?

   b. How do you quantify training?

   c. How much training is 'enough'?

   d. How do you compare 'apples and oranges'?

4. The work described was carried out by a number of different Agencies, Departments and contractors. CDA(HLS) and their sub-contractors produced the majority of the data used; other major contributions came from the Procurement Executive, the Equipment Support agencies and the Directorate-General of Doctrine and Development. The Directorate of Science(Land) was responsible for pulling together the data into a single COEIA report and for carrying out a large number of 'what-if' variations in order to answer the wide range of questions raised during the final staffing process.

INTRODUCTION

5. The work described was carried out in support of the UK Combined Arms Tactical Trainer (CATT). CATT is intended to train battalion-sized all arms formations known as battlegroups in the UK. The options considered were:

   a. Do Nothing - the baseline case corresponding to current training.

   b. Increased use of existing training systems.

   c. Addition of company-level distributed interactive simulation training (e.g. US Close Combat Tactical Trainer CCTT).

   d. Addition of battlegroup-level distributed interactive simulation training.

6. These options differ markedly in the amount and type of new equipment to be procured, and in the proportion of time spent in a particular training equipment. As a result, they can only be properly compared on the basis of the overall change in battlegroup performance, not on their ability to train a defined sub-set of tasks. Each option therefore defines a complete battlegroup-level training package containing a number of complementary training systems, based on current training (Option 1 - Do Nothing) but with different forms of

extra training corresponding to the option title. The initial work compared these training packages ('Options') on the basis of whole life cost to produce constant effectiveness; however, during the staffing of the COEIA we were asked to consider so many different levels of effectiveness that we ended up calculating the complete cost versus effectiveness relationships.

OVERALL METHODOLOGY

7. Everyone knows that training is a 'good thing', but objective quantification of 'how much' and 'in what manner' is considerably more difficult. At the lower levels of training, the requirement definition usually relies on the identification of a number of missions or tasks which must be performed by the trainee and the subsequent decomposition of these tasks into one or more lower level sub-tasks which form the training requirement. A candidate training system is then assessed to determine its ability to influence performance in each of the relevant sub-tasks ('meet the requirement'). The most cost-effective system is then that which most fully meets the requirement at the lowest cost.

8. Unfortunately, this methodology (at least, in its simplest form) assumes that sub-tasks can be treated indepently and in a linear, hierarchical fashion e.g. first tie your shoelaces then stand up. This assumption is fine when dealing with the simpler low-level skills, but breaks down at the higher level tasks typical of a battlegroup where the tasks are more equivalent to 'tie your shoelaces whilst standing up and holding an intelligent conversation'. At any one time, several sub-tasks are being pursued in parallel, and the overall desired end-result (the 'mission') can be reached by several different routes; indeed, research sponsored by the Ministry of Defence has concluded that the number of possible combinations of tasks and sub-tasks is unmanageable at the battlegroup level. Some simpler method of assessment is therefore needed.

9. The approach used to quantify effectiveness for the CATT COEIA was to concentrate on the overall battlegroup performance in terms of the probability of mission success, rather than on individual tasks and sub-tasks - 'winning the war' rather than getting 'ticks in boxes'. Note that 'probability of mission success' refers to the performance demonstrated, not necessarily to 'Win' or 'Lose'. For example, almost achieving the mission against a competent enemy may indicate a higher performance level than fully achieving the mission against an incompetent enemy.

10. This required 3 things:

a. A means of quantifying battlegroup performance under a manageable number of parameters.

b. A means of predicting the probability of mission success from these performance parameters.

c. A means of relating the battlegroup performance parameters to the training history.

BATTLEGROUP PERFORMANCE PARAMETERS

11. There are many possible performance metrics that could have been used, but the CATT COEIA used the 6 Functions In Combat (FICs) defined in British Army doctrine:

a. Firepower.

b. Manoeuvre.

c. Protection.

d. Command.

e. Intelligence.

f. Combat Service Support.

12. These 6 FICs may not be scientifically optimum, but they come directly from the fundamental basis of doctrine; this ensures that training assessment is in line with all other Army operations. They are already used to indicate performance in some current training systems. Some consideration was given to combining these 6 FICs into a smaller number of metrics; a single metric was however rejected as meaningless since it doesn't specify where the deficiency lies. For example, if someone is 'half-trained' does this mean that they are half-trained in all FICs, or that they are fully trained in some and untrained in others, or what?

13. Each FIC is defined on a basis of 1 to 5, with 1 being untrained and 5 being perfect. Additionally, a score of 0 is used if that FIC cannot be assessed for any reason. A score of 3 means that the mission should be just achieved against an 'average' enemy, but with some significant problems. This score is based on that currently used for the assessment of British Army units in field training exercises;

PROBABILITY OF MISSION SUCCESS

14. The CATT COEIA represented the first use of a new model developed by CDA(HLS) specifically to include the effects of training on battle performance. This model is known as the Collective Performance Model (CPM); it is a battlegroup-level stochastic simulation using both time and event stepping, and covers game periods of several hours. Combat Service Support is not directly represented in CPM; it affects the start states (e.g. ammunition available) instead. The other 5 FIC scores are used to modify a number of parameters in the model. For example, a low score in the Intelligence FIC means that enemy units may not be seen, and the locations of those that are seen may be in error. In simulation terms, this results in the enemy being able to fire first and return fire being directed to the wrong place.

15. The CPM runs fairly quickly; a single run of a 5-hour battle will typically require less than 30 minutes on a high specification PC, although several tens of such repetitions are usually necessary to achieve reliable statistics regarding outcomes. The main area of difficulty lies in covering a sufficiently wide range of potential outcomes in the simulation script, but the battle can be viewed on the PC screen as it happens which aids de-bugging. It is also necessary to ensure that the definition of 'mission success' is consistent with the simulation script; for example, if mission success is defined as an enemy withdrawal then there should be something in the script to trigger such a withdrawal.

PERFORMANCE AND TRAINING HISTORY

16. Subject Matter Experts (SMEs) were used to identify the time required by each relevant training system to raise each performance parameter by a certain amount, and also the time taken for that particular performance parameter to decay by a certain amount in the absence of further training. The change in performance depended on the start level and the time taken; Figure 1 shows a typical relationship. At low performance levels, only a short time is needed to improve performance and a long time is needed for that increase to decay back to

the original level. Conversely, at high performance levels, much time is needed to improve performance further and this improvement decays relatively rapidly. Different training systems will have different performance-time relationships, and may be ineffective at training some FICs, particularly at the higher performance levels.

17. These performance-time relationships were then used to define optimised combinations of training systems called training packages, each of which produced the required overall training result whilst respecting the limitations specific to the included training systems.

OVERALL COEIA

18. The CATT COEIA consisted of a comparison of the cost-effectiveness of a number of different training packages, each one containing a mix of existing training systems and one of the potential CATT options. This process is outlined in Figure 2; the various steps have been described above.

19. As mentioned previously, we started out comparing options on the basis of their discounted whole life cost at constant effectiveness but so many 'what-if' qestions were raised concerning the implications of different effectiveness levels that the complete effectiveness versus cost relationships were derived. Figure 3 shows a 'sanitised' version; the axes do not necessarily start at zero, neither are they necessarily linear. Two curves are shown for the battlegroup-level training simulator; these correspond to different assumptions and indicate typical uncertainties. They have been shown for this option only in order to keep the figure (relatively) simple.

20. It can be seen that increased use of current training systems is the least cost-effective solution, and requires additional field training areas in order to reach high levels of effectiveness. The addition of a company-level simulation-based trainer helps to reduce the number of company-level and below field exercises; it therefore becomes more cost-effective than increased use of current training systems, but still requires additional field training areas to reach the higher effectiveness levels. Incorporation of a battlegroup-level simulation-based trainer now allows some of the battlegroup-level field training to be shifted to the simulators; this produces major savings, so once the initial procurement cost has been overcome, the low running costs per training hour make this the most cost-effective option even for quite modest increases in effectiveness above the current level.

Figure 1 : CP change with time.

Optimal training, no turbulence.

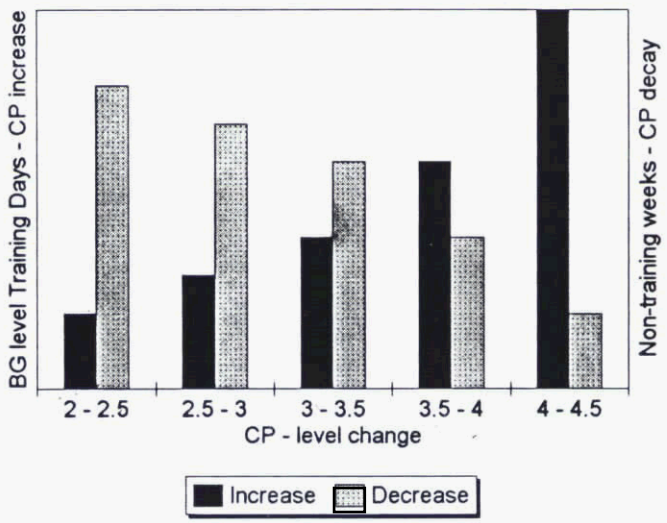

Figure 2 : OA in support of CATT

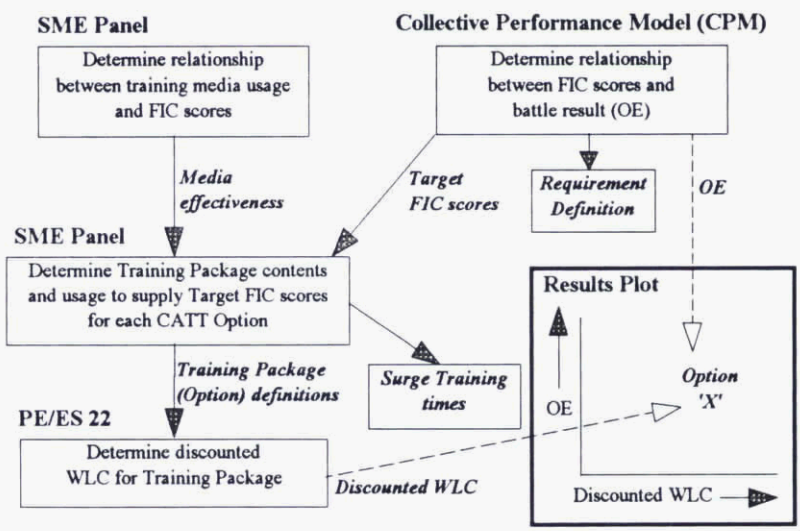

Figure 3 - Cost vs. Effectiveness