19 SEPTEMBER 2022

MEMORANDUM FOR Dr Vikram Mittal, SE485 Professor

SUBJECT: Analysis of Combat Simulation versus ACFT scores.

1. Resources and References:

   a. Mittal, Vikram (2022). Combat Modelling Notes.
   b. Microsoft Corporation. (2018). Microsoft Excel.
   c. Fox J, Bouchet-Valat M (2022). Rcmdr: R Commander. R package version 2.8-0.

2. The purpose of this memorandum is to evaluate the results of a combat simulation that correlates the ACFT scores to the accuracy of target acquisition and shooting effectiveness on the battlefield.

3. The data collection event consisted in 3 series of 20 rounds at a target 175m away performed by 23 cadets in the EST range. Each series returned the Fixed and Variable Bias for both horizontal and vertical directions. These cadets also reported their ACFT scores.

For an initial processing of this data, it was applied a regression to this values that generated coefficients of impact. Using these coefficients, it is possible to calculate the approximated horizontal and vertical biases for any individual using their ACFT scores.

4. The combat modeling was built combining target acquisition and casualty assessment techniques. For casualty assessment, it was used some given probabilities of survival and incapacitation time considering the body area of hit.

The target acquisition section used the ACQUIRE model as base. This model was used by Night Vision and Electronic Sensors Directorate (NVESD) for the development of a new metric called Targeting Task Performance Metric (TTPM). Using this metric, it is possible to measure the probability of acquiring a target based on the environment (for these purposes, it was considered an Urban Environment with Personnel Target).

5. The simulation run considered a scenario of Blue Forces with variable scores performing against the Red Forces, with minimum ACFT scores, in the Battlefield. By changing the Blue Force test scores, it is possible to analyze the effects of each parameter. For this report, it will be analyzed the impact of the following ACFT tests: Hand Release Push-Ups, Plank and Deadlift. The criteria for their choose was the highest three results of all absolute coefficient values sum.

The simulation scenarios run for the analysis are explicit on the table below. The Red Forces values were fixed as low (60) for every score. The Blue forces values were changed according to the table between high (100) and low (60), the remaining test scores were kept at a medium value (80). The results taken were generated twice with different stochastic seeds and they correspond to the number of wins for blue and red forces.

PU	PL	DL	Blue Wins	Red Wins
High	High	High	485, 474	450, 456
High	High	Low	506, 507	430, 424
High	Low	High	458, 464	474, 465
High	Low	Low	442, 459	489, 467
Low	High	High	379, 369	547, 541
Low	High	Low	451, 447	482, 483
Low	Low	High	430, 430	498, 495
Low	Low	Low	461, 458	474, 469

Table 1: Simulation results
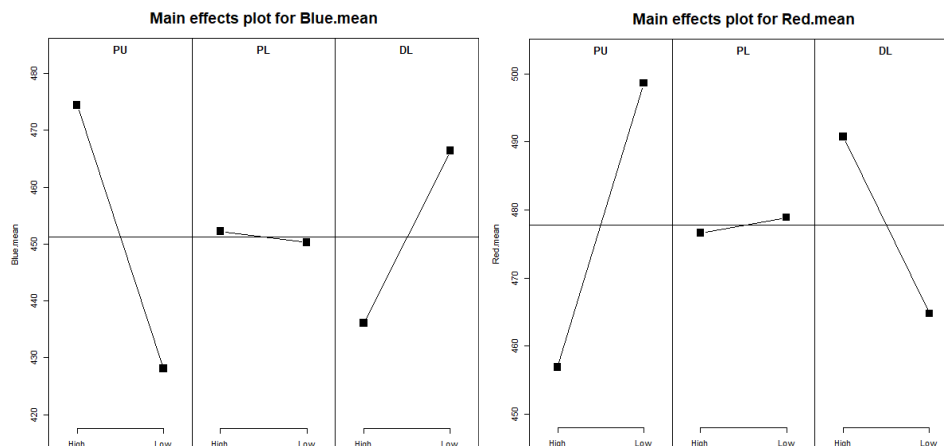

Figures 1, 2: Main effects plots

The plots above were generated using the *RCmdr* plugin. The y-axis shows the mean of wins for both blue and red sides. The fact that the results are mirrored is expected since the fact that some skill is favorable for one side make it be bad for the other one.

Looking at the results, the greater impact of the ACFT scores in the battlefield performance seems to be attributed to the push-ups because the grade is hugely related to the number of wins. The Plank seems to have a small impact but having a good score is also favorable in the battlefield.

The most confusing result is the one obtained for Deadlift in which the high ACFT scores seem to have a bad impact in the number of wins. If the results had a small significance, it could be considered that this exercise had no impact. But the fact that line has a big

decline makes them important enough to be taken in consideration and maybe worth of an analysis from physical education professionals.

For helping understand this particular result, the interaction plot can compare the significance of this test when combined to others. When the individual has a higher push up score, the result has a lower impact. For this reason, the issue to be more profound considered is the fact that, when there are lower pushups scores, the deadlift seems to have a bad impact. This fact can also be due to the small number of individuals involved in the model base test.
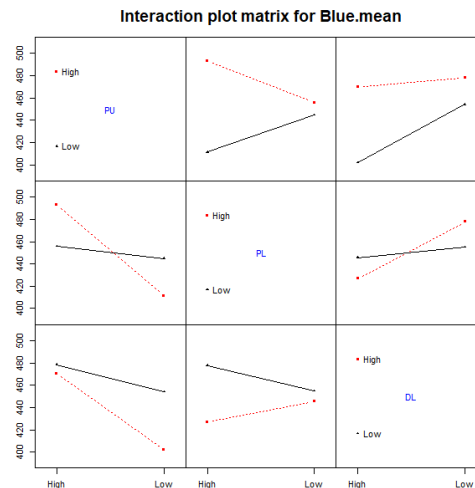
Figures 3: Interaction plot

The number of wins is pretty similar to the lethality potential, but some final considerations may be made concerning the survivability. For having a better understanding of this metric, the number of draws should also be considered but, for these variations, it has been approximately constant. So, a good lethality is also a good survivability for this test.

6. As inferred by this detailed analysis, the impact of the ACFT scores can have different weights in the shooting performance. It is recommended that this test is taken using a larger range of cadets for data collection, making it possible to evaluate the impact of the ACFT scores based in more accurate coefficients and even consider all tests results. Despite the limitations of this simulation, the results can be considered satisfactory.

MAYARA R. MENDONCA
CDT '23
Military Engineering Institute, Brazilian Army