82nd Airborne Divison Outload Decision Support Tool

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Introduction

The 82nd Airborne Division serves as the core of America's strategic response force, and provides the ability to execute global force projection through large scale combat parachute assault operations. A detailed outload plan is necessary to rapidly deploy the Global Response Force (GRF). This outload process involves prioritizing vehicles, and then assigning these prioritized vehicles to available aircraft.

Problem Definition

Our team collaborated with the 82nd Airborne Division Operational Research and Systems Analysis (ORSA) Cell in developing an Outload Decision Support Tool (ODST) that rapidly builds and adjusts the Priority Vehicle List (PVL) and optimizes vehicle assignment to various types of aircraft given a mission profile and a unique brigade vehicle list.

LP Formulation

This is the objective function and constraints for the assignment of vehicles to aircraft. X_{av} is the binary decision variable.

$$\min \quad \sum_{a\in A}\sum_{v\in V} X_{av} pvl.pref_{av} + \sum_{a\in A} avail.feet_a - \sum_{a\in A}\sum_{v\in V} X_{av} veh.feet_v$$

$$\text{S.T.} \quad \sum_{a\in A} X_{av} \geq 1 \qquad \forall v \in V \tag{1}$$

$$\sum_{v\in V} X_{av} veh.feet_v \leq avail.feet_a \qquad \forall a \in A \tag{2}$$

$$\sum_{v\in V} X_{av} veh.weight_v \leq avail.weight_a \qquad \forall a \in A \tag{3}$$

$$X_{av} \in \{0,1\} \tag{4}$$

Heuristic Algorithm

Algorithm 1 AC Assignment Algorithm

```
for each veh on the PVL do
  if veh is loaded then
    Move on to next veh
  else
    for each available ac do
      if usable ac length > veh length and available ac weight > veh weight then
        usable ac length = usable ac length − veh length
        usable ac weight = usable ac weight − veh weight
        label veh with ac number
      else
        label vh with "Does not Fit"
      end if
    end for
  end if
end for
```

Results 1

	Heuristic Algorithm	Integer Program
Number of AC	26	26
Empty Space	48 feet	48 feet
Sum of Deviations from Original PVL	34	486

Table 1: Comparison of Linear Program to Heuristic Algorithm

The table above compares Linear Programming and the Heuristic Algorithm for use in assigning vehicles to aircraft.

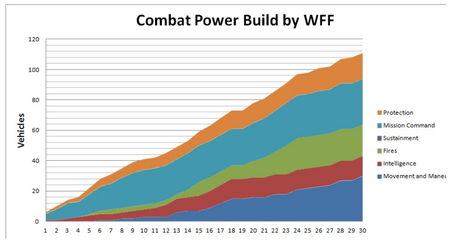


Figure 1: Combat Power Build by War Fighting Function

Both algorithms were equivalent for minimizing aircraft and empty space, but the heuristic algorithm was superior in terms of minimizing changes to the prioritized list. The ODST uses the heuristic algorithm for assignment.

Figure 1 provides a visualization of combat build by warfighting function. This graphic allows commanders to visualize the total number of vehicles by category available at various times during the mission, stimulating re-prioritization if the mix of vehicles is not appropriate for a given time frame.

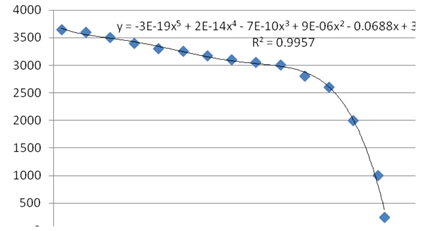
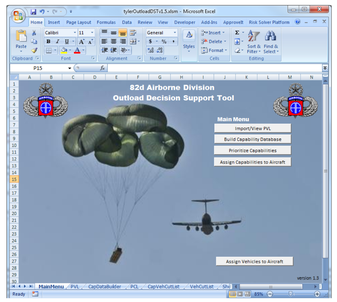


Figure 2: C130 Range (nm) as a function of load

The range calculator serves to provide the user with an accurate estimation of the max range capability of the C130 and C17 aircraft based on their payload. Figure 2 provides the function for estimating C130 range as a function of load.

Implementation and The Way Forward



The 2nd Brigade Combat Team will test and evaluate the Outload Decision Support Tool (ODST) as they prepare to take over responsibilities of the Global Response Force and become the first brigade of the 82nd Airborne Division to transition to the new "Brigade Combat Team 2020." The ODST will facilitate development of a new Priority Vehicle List to support this new brigade structure.

References

[1]Department of the Army, 2013, "Response Standing Operation Procedures," Fort Bragg, NC.
[2] Kevin, Y. K., 1992 "A multicritieria optimization approach to aircraft loading," Operation Research, 40(6) 1200-1205.

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