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Logistics Supply of the Distributed Air Wing

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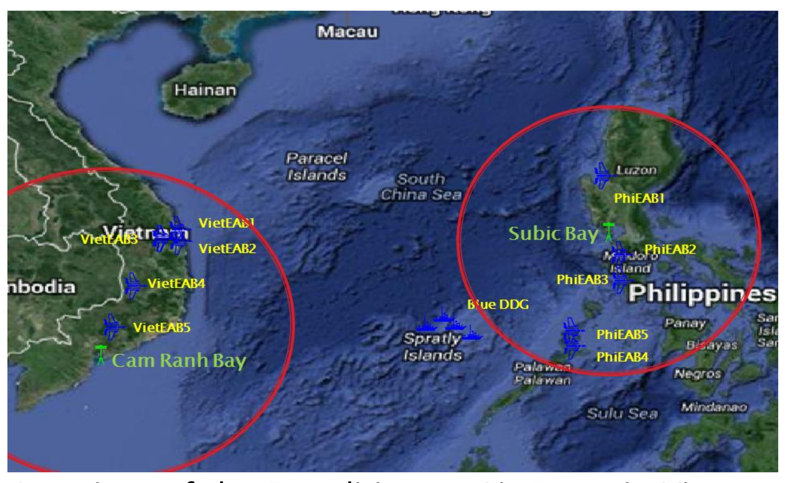
Abstract

The use of the aircraft carrier has been the norm for delivering sizable amounts of air power swiftly to any part of the world. A capstone project, conducted by the system-engineering curriculum, proposed to distribute the air assets from the aircraft carrier to multiple Expeditionary Airbases (EABs), which are land bases located within the operating theater. This thesis studies the logistical demands of the EABs, and adopts the Marine Aviation Logistics Support Program II (MALSP II) concept for the logistics supply of the Distributed Air Wing. Airship, fixed wing Unmanned Air Vehicle (UAV), and rotary wing UAV are explored as the main cargo transportation means.

This thesis develops a vehicle routing optimization model to optimize the transportation fleet size and mix, and a discrete event simulation to analyze the logistics concept. Experiments are conducted to determine the feasibility and cost-effectiveness of using cargo UAVs, using cargo trucks as a reference for comparisons. All platforms achieved the three days turnaround time, as stipulated by MALSP II. The airship is found to be the most cost-effective solution. Rotary wing and fixed wing UAVs deliver their supplies much faster, but are more suitable for quick response missions, instead of large cargo deliveries.

Overview of Distributed Air Wing

- Capstone project conducted by the System Engineering Department
- Distribute the air assets from the aircraft carrier to land Expeditionary Airbases (EABs) located around the operating theater [1]



Locations of the Expeditionary Air Bases in Vietnam and Philippines

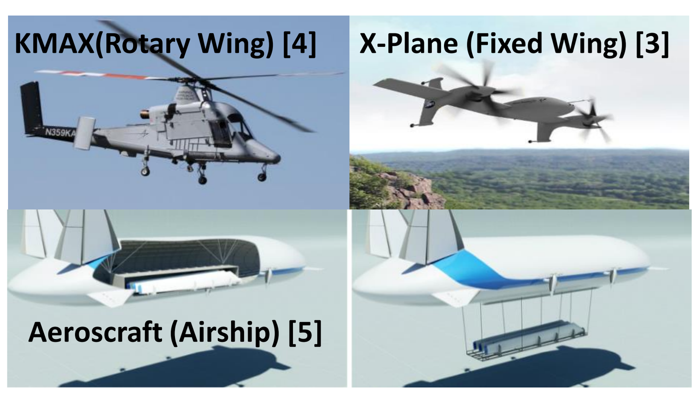
Logistics Concept – Marine Aviation Logistics Supply Program II

- Marine Aviation Logistics Support Program II (MALSP II) [2]
  - Just in Time, Push Pull Concept
  - Hierarchical Supply Chain from parent supply depot to EABs

Linking the Vietnam and Philippines EABs to the Parent Supply Depot via the North Atlantic Route and the Pacific Route

Using Unmanned Systems For Cargo Delivery

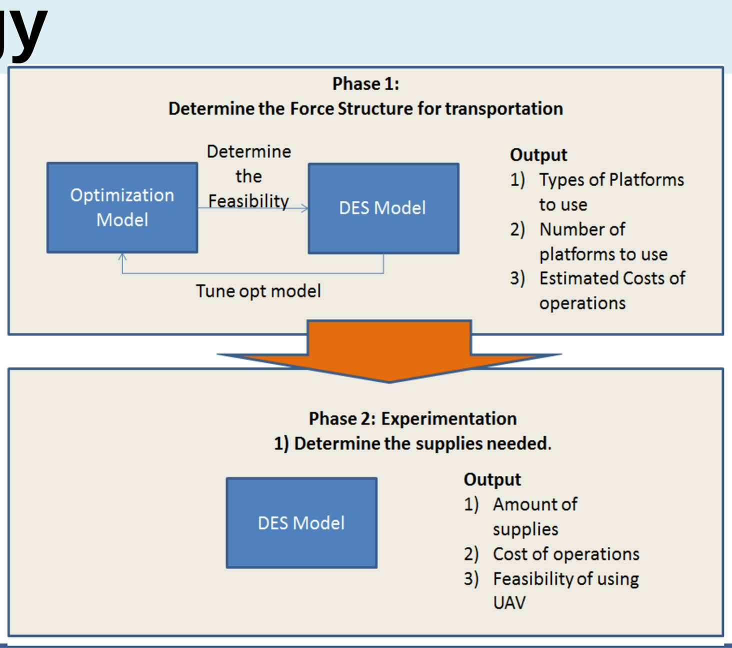
- Airship
  - Large Payload Capacity
- Fixed Wing Unmanned Air System (UAS)
  - Vertical Take Off Landing (VTOL)
  - High speed, low payload capacity
- Rotary Wing Unmanned Air System
  - Proven technology in Afghanistan



Examples of UAS currently in service or explored by DARPA and DoD

Methodology

- Phase 1: Fleet Optimization
  - Find the optimal transport fleet size and mix using vehicle routing problem
  - Uses Discrete Event Simulation (DES) to verify feasibility of optimization
- Phase 2: Experimentation using DES
  - Platforms cost comparison and supplies count sensitivity analysis



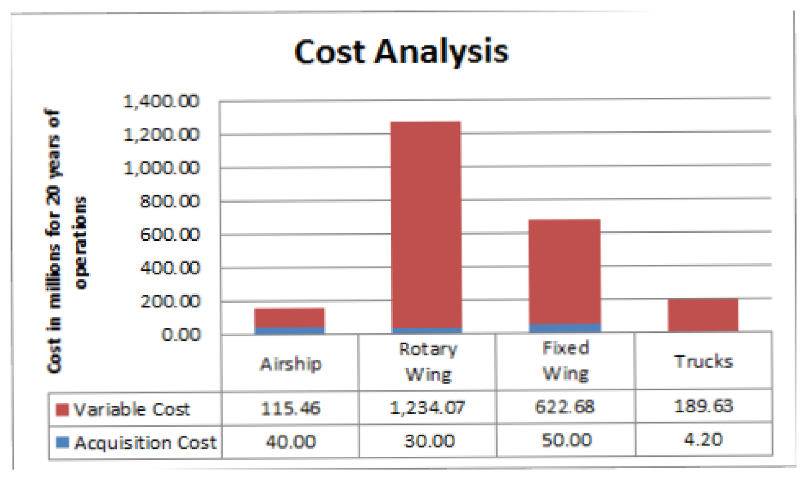
Optimization Results

- Improved the accuracy of the optimization model by using discrete event simulation to verify the feasibility of model and mitigate the stochastic effects

Performance	Airship	Rotary Wing	Fixed Wing	Trucks	Fleet Size and Mix
Optimization Model Results	1	8	5	13	1 Airship
After Tuning	1	6	2	14	1 Airship

Experiments Results

- Airship is the most cost-effective solution
- Too costly to operate fixed wing and rotary wing UAS for large scale cargo delivery but they are more suitable for high speed and small cargo delivery
- Cargo trucks operations are cheap but they are too manpower intensive



	Airship	Rotary Wing	Fixed Wing	Trucks
Platforms Required	1	6	2	14
Operating Hours per Day	10.54	18.78	14.22	18.55
Personnel Required	1	12	4	28

Table 6.10: Manpower Required to Operate each Vehicle Type, in Terms of Operators assuming 12-hour Workdays

Benefits and Future Works

- Improved accuracy of the models using the optimization results with the simulation models
- Promising future for cargo UAS
  - Declining cost due to entry of commercial companies
  - Planned ratio of 1 pilot to 6 UAV could mitigate pilots' workload [6]
- Future Exploration
  - Effects of the entire MALSP II supply chain
  - Using Unmanned Systems for logistics convoy protection
  - Effects of interruptions to the logistics supply
    - For example: Attacks by adversaries, Poor weather

References

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