Operations Research in the Department of Defense

Jason Daly
Senior Operations Analyst for Marine Corps Operational Test and Evaluation Activity (MCOTEA)
Outline

- Background on Operations Research (OR)
- How it applies to DoD and other government agencies
- Example of my work
What’s OR?

- Operations research is the application of scientific and mathematical methods for the analysis and study of problems involving complex systems
  - Scientific
  - Mathematical
  - Involves modeling/simulation
  - Applies to real-world operations
OR Beginnings

- WWII and the British and American Militaries as they dealt with new and effective technologies
Classic search problem

- How do you find a submarine you can’t see?

![Graph showing probability of detection vs. percentage of area searched. The graph compares random search and ideal search, with the ideal search reaching higher probability of detection at the same area searched. The graph indicates a significant improvement from random search to ideal search or better.](image)
Structured tactical searches

Variables:
- Altitude
- Speed
- Detection Aids (Binoculars, Radar, etc.)

Initial Alert Position

Search pattern

Dispersion of likely submarine paths
What OR is now

- Computing and information technologies
- Decision analysis
- Environment, energy, and natural resources
- Financial engineering
- Manufacturing, service sciences, and supply chain management
- Policy modeling and public sector work
- Revenue management
- Simulation
- Stochastic models
- Transportation

Institute for Operations Research and the Management Sciences (INFORMS)
What OR is now

- Computing and information technologies
- Decision analysis
- Environment, energy, and natural resources
- Financial engineering
- Manufacturing, service sciences, and supply chain management
- Policy modeling and public sector work
- Revenue management
- Simulation
- Stochastic models
- Transportation

Institute for Operations Research and the Management Sciences (INFORMS)
More modern question…sortie generation

- How many aircraft can you launch off an aircraft carrier?
- How long can you keep the pace?
Then what?

Once you understand all the small tactical pieces of operations, you can move onto the bigger strategic picture...

How do you coordinate a major combat operation?
Who needs OR?
What kind of background do you need?

- **Analytical and technical!**
- Programming and modeling skills are useful
- B.S. will start you out, but Masters and Ph.D. will get you further, faster
- Almost always requires a background check
- Look for summer internships
My Background...Physics Undergrad

\[ E\Psi = \hat{H}\Psi \]

\[ i\hbar \frac{\partial}{\partial t} \Psi = \hat{H}\Psi \]

\[ \mathbf{F} = q\mathbf{E} + q\mathbf{v} \times \mathbf{B} \]
My Background…Physics Ph.D.

Nova Cygni 1992

(p,\gamma) 

\begin{align*}
\text{Beta decay} & \quad \rightarrow \\
(p,\alpha) & \quad \rightarrow
\end{align*}

Triton spectra

- No gold backing
  - \(a = 4.01\) MeV
  - \(b = 4.14\) & \(4.20\) MeV
  - \(c = 4.38\) MeV
  - \(d = 4.55, 4.60\ & 4.64\) MeV

- Gold backing
My Background…OR Analyst

- 2003-2009, Research Analyst at the Center for Naval Analyses (CNA)
- Currently Senior Operations Analyst for the Marine Corps Operational Test and Evaluation Activity (MCOTEA)
Small Unmanned Aerial Vehicle (UAV)

Problem: What is the utility of a small ship-launched UAV during deployed operations of an Expeditionary Strike Group (ESG)?

Real Problem: We found a really cool toy. Where can we use it, and how many should we buy?
Use the scientific method

- Characterizations/Question*
- Hypothesis development
- Predictions from the hypothesis
- Experiments
- Evaluation and conclusions
What’s a Unmanned Aerial Vehicle?

It’s an airplane with no pilot. It’s mostly autonomous and seldom “remote controlled.” It generally carries Electro-optical and IR cameras, radars, and other sensors.

Big ones, like Global Hawk

Tiny ones, like Raven
Questions

What are the current capabilities of the ESG?
What are the capabilities of the small UAV?
What type of operations are you planning?
Smallish, but very capable
Build a hypothesis, make predictions

- UAV support of the Recognized Maritime Picture (RMP)
- UAV support to Maritime Security Operations
- UAV support of Maritime Operations Ashore

Used modeling to predict which missions would be viable.
Send it to real world operations

- Did a lot of testing over a lot of ocean and land
- 6 Months deployed
- 1000s of hours of operations
- Lots of data points
I can’t tell you.

But, this UAV is still not an official Navy Program of Record.
Questions?