Nuclear Wargaming

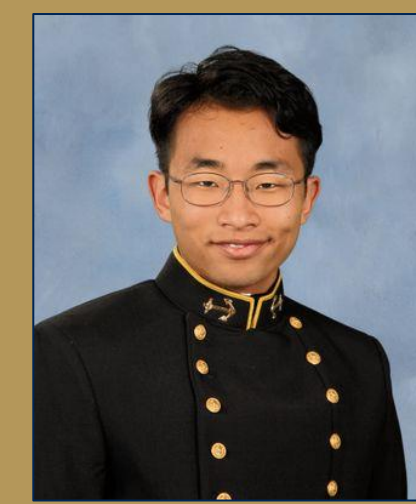United States Naval Academy — Nuclear Weapons Team

Midshipman 1/C Brandt Midshipman 1/C Davis Midshipman 1/C Hong Midshipman 1/C Hoover Midshipman 1/C Minor

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MNE

USNA MECHANICAL AND NUCLEAR ENGINEERING

Problem Statement

Design a software tool that calculates overpressure, thermal effects, and radiation exposure on a Carrier Strike Group (CSG) and its personnel for use in a wargaming situation.

Background

- "Tactical" nuclear weapons are defined as weapons with a yield between 1-100 kT of TNT.

- A CSG is a battle group comprised of 5-7 ships centered around an aircraft carrier.

Customer Requirements and Engineering Characteristics
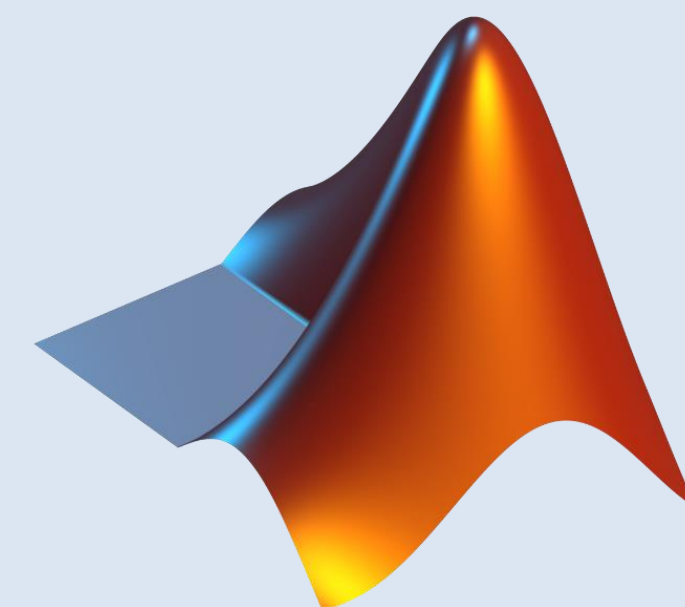
MINES
mines.dtra.mil

Customer Requirements

- User Friendly Software
- Fast Software
- Inexpensive Software

Engineering Characteristics

- Processing Time
- Volatile Memory Storage (GB)
- Cost (USD)
- Storage Space (GB)
- Number of Input Variables

Prototyping

MATLAB   Python

Design 1:   Design 2:   Design 3:

Poseidon   **Fallout Boy**   **Omniblast**

- MATLAB
- Requires License
- Limited Versatility

- Python (OpenMC)
- Accounts for Fallout

- Python
- Fallout Not Included

Results to be within 20% of MINES

Testing & Evaluation

1000 Series – Terminal Shell Code
- Test 1100: Overpressure Tests
- Test 1200: Thermal Tests
- Test 1300: Radiation Dose Tests

2000 Series – Integration to Python
- Test 2100: Proof of Concept Tests
- Test 2200: GUI Implementation Tests
- Test 2300: Map Implementation Tests
- Test 2400: Underwater Tests

3000 Series – Refinement of Code
- Test 3100: Proof of Concept Tests
- Test 3200: Underwater Deep Ocean Tests
- Test 3300: Underwater Harbor Tests
- Test 3400: Final Wargaming Tests

Results and Final Design

Height/Depth of Burst Input (m): 0
Input Weapon Yield (kt): 1
Current Visibility: Clear (10-20km)

Enter

Randomized Input Height Burst=15 m

Select Map: Pearl Harbor (Shallow Water Port)

☐ Check if it is an underwater detonation   ☐ Check if carrier is conducting flight ops

Add Carrier | Add Cruiser | Add Destroyer | Add Supply Ship | Clear Ships

Finalize Ship Location

Carrier: 921.80 meters
Cruiser: 1666.17 meters
Destroyer: 399.44 meters
Supply Ship: 1870.26 meters

Peak Overpressure Calculation: Thermal Calculation: Radiation Calculation:

Calculate   Calculate   Calculate

Carrier: 1.82 psi.-Safe
Cruiser: 0.81 psi.-Safe
Destroyer: 6.62 psi:-Safe
Supply Ship: 0.69 psi-Safe

Carrier: 1.17 cal/cm^2-All Personnel Safe
Cruiser: 0.31 cal/cm^2-All Personnel Safe
Destroyer: 6.87 cal/cm^2-Exposed personnel burned
Supply Ship: 0.24 cal/cm^2-All Personnel Safe

Carrier: 371.79 rads-Operationally Damaged
Cruiser: 8.71 rads-Safe
Destroyer: 7481.44 rads-Kill
Supply Ship: 2.56 rads-Safe

Acknowledgements