Vision:
To help midshipmen and other U.S. Navy personnel learn to correctly use a maneuvering board by creating an online interface that visually walks the user through solving the basic forms of maneuvering board problems.

Background and Motivation:
Between and 5,000 and 6,000 officers join the United States Navy every year. Every officer, regardless of which branch of the Navy he or she enters, is required to learn basic Navy skills and knowledge. At a typical Naval ROTC unit, this information is taught over 8 semesters as follows:

1. Introduction to Naval Science
2. Navigation
3. Naval Maritime History
4. Leadership and Management
5. Naval Weapons Systems
6. Naval Engineering
7. Naval Operations
8. Leadership and Ethics

While the content is new, the structure of each class reflects what students see in their regular undergraduate academic studies. (1) and (3) are taught as large lecture type classes, (5) and (6) are similar to medium size calculus or physics classes, while (4) and (8) are taught as small discussion-heavy courses. Midshipmen are used to these class structures, which makes learning the material easier. (2) and (7) present a unique challenge for teachers, with a bulk of the material involving students learning to read maps, chart courses, and plot absolute and relative motion of ships. They are hands-on, repetition-intense, process-focused classes, and consequently, harder to learn in than the other six Navy courses.

One of the key concepts learned in Navigation and Naval Operations is how to use a Maneuvering Board (MoBoard). A MoBoard is a polar plot with scales on the sides that make plotting relative and absolute motion of your vessel and contact vessels quick and easy. Currently, the only learning aids available to learn MoBoard techniques are manuals, PDFs and videos. If the teacher is unavailable, learning from these aids is challenging as the process is extremely visual and not easily conveyed statically. Creating an aid that would interactively walk Midshipmen through MoBoard problems would make learning the material easier on students and teachers.

Functionality:
This learning aid is an interactive graphical user interface that will walk users through how to set up and solve MoBoard problems. The basic MoBoard problem plots the motion of a contact vessel and then determines the closest point of approach (CPA) and whether or not risk of collision exists. In the basic form of the problem with 1 contact vessel, there are 8 knowns that the program will take as input:

1. Own vessel speed
2. Own vessel absolute direction
3. Contact 1 bearing
4. Contact 1 range
5. Contact 1 time
6. Contact 2 bearing
7. Contact 2 range
8. Contact 2 time

After receiving input, the GUI will break into two components: explanation of process on the left, and a MoBoard graphic with animation on the right. The aid will explain (left side) and visually demonstrate (right side) how to find the following pieces of information:

1. Determine relative motion of contact vessel from the two points of contact
2. Determine absolute motion of contact vessel using a speed triangle
3. Solve for closest point of approach (bearing, range, and time)

Underlying Mathematics and User Interface:
There are two essential programming challenges associated with this learning aid. The first is understanding the underlying trigonometry and math that makes MoBoards fast and easy to use. In a physical MoBoard interface, the user relies heavily on using scales, physically plotting lines, and visually locating intersections. Since the program will be blind to any physical interface, the aid will need to represent all the information mathematically using formulas. I will have to convert the process from a visual one to a computational one so that the aid can solve the problems in real time and graphically represent the solution on the digital MoBoard.
The second challenge is programming the user interface. I would like the initial implementation to just cover basic functionality, without worrying too much about visual appeal. With this in mind, I plan on programming in python, using the basic Tkinter GUI package to take care of graphics and basic animation.

Talking with Naval Officers, some with 15+ years of Naval experience, I will focus on programming the aid to work on an offline, windows platform. A majority of the Navy uses windows based machines, some with limitations on internet access, so it is important the application can be used offline.

**Similar Technology:**
After searching online and talking with Naval Officers, I was not able to find any program with similar capabilities. Learning aids for Maneuvering Boards are limited to the following:

- **PDFs/Powerpoints:**
  - [http://www.boatswainsmate.net/BM/MOBOARDS.pdf](http://www.boatswainsmate.net/BM/MOBOARDS.pdf)
  - [http://www.boatswainsmate.net/BM/MOBoards101](http://www.boatswainsmate.net/BM/MOBoards101)

- **Videos:**
  - [https://www.youtube.com/watch?v=9Qov01O1mg8](https://www.youtube.com/watch?v=9Qov01O1mg8)
  - [https://www.youtube.com/watch?v=yrfi6CyozZ4](https://www.youtube.com/watch?v=yrfi6CyozZ4)

Naval learning aids do exist for other skills. Any person who operates watercraft, including all Navy personnel, need to know the rules of the road, which govern how ships are allowed to maneuver relative to each other. This is a skill that requires brute memorization of the rules, but is best learned by repeatedly analyzing pictures instead of just memorizing text. This was successfully digitized as a learning aid by Bhandarkar Publications (among others) and is available for android and ios via the android and iTunes app stores.

**Deliverables:**
By the end of the semester, I will have a completed version of the MoBoard learning aid that can walk students through solving a basic MoBoard problem. Time permitting, possible extensions to the project include:

- Moving the technology to other platforms (Mac, Online, etc)
- Improving the graphics quality
- Solving advanced MoBoard problems
- Being able to take different combinations of input in the basic solution (e.g. already given contact relative motion instead of having to solve for it)

---

4 [http://www.navcen.uscg.gov/?pageName=navRulesContent](http://www.navcen.uscg.gov/?pageName=navRulesContent)