SPU 26: Primitive Navigation

Syllabus Fall 2016

Modern technology insulates us from our environment to the point where we hardly pay attention to the natural world around us. In contrast to those who relied on natural signs for a livelihood hundreds of years ago, weâ€™ve lost the ability to see meaning in the clouds, the sun, the stars, shadows, waves, tides, and currents. All of this meaning disappears behind electronic communications with satellites, vast sensor networks, and supercomputer models. We propel metal cages over asphalt highways and across oceans with little effort, relying on massive consumption of fossil fuels.

Yet centuries ago, humans harnessed the wind to cross vast distances, inventing reliable navigational strategies and using unarticulated laws of nature to find their way. Their lives depended on it.

In this course we will:

- Explore the underlying physical principles involved in navigation through observation of natural phenomena.
- Show the student how to observe and use these signs as practiced in the past.
- Examine the cultures of navigation in Polynesian, Norse, Arab and early Western seafaring.

Rather than present a disparate set of facts as science, the course aims to build on material over the weeks with a coherent progress. During each week, weâ€™ll take on a new topic. Much of the course has historical descriptions of the development and use of techniques, the science behind them, and emphasizes the experience of using these as a primitive navigator.

While one goal is understanding basic principles of navigation, there are a set of other concepts I want the students to explore. These get to a deeper root of the goals of the revised Gen Ed program:

- Navigation as a cognitive practice is mirrored in other domains, like future planning, social interactions, among others. We explore this using navigation as a reduced, bounded problem that involves the same cognitive processes. For example, how can we combat confirmation bias?
- Dealing with uncertainty: navigation is a highly reduced form of empiricism aimed at answering the question â€œwhere am I?â€. The answer can be found in multiple ways, and the knowledge can be expressed within the bounds of an uncertainty. We sometimes need to give ourselves permission to be wrong in order to learn.
- Direct contact with the environment â€“ too often we sleepwalk, oblivious to what the clouds, the sun, or the shadows are telling us. This is an exercise in mindfulness.
- Casting off high-technology â€“ the term â€œautomation biasâ€ describes the notion that if an answer comes from a computer or smart-phone, it must be correct. Often times, it isnâ€™t. By shedding these tools for the course, we develop more of an automation-free intuition. In addition, we gain insight into cultures that are not technologically sophisticated. We often make the mistake that high-technology = sophistication.

Throughout the course, we will revisit these themes, both in lectures and part of the reflective component of the assignments.

The first half of the course discusses human navigation, its history and practice. The second half describes topics facing a person setting out to do long distance travel: currents, winds, weather, how sails and boats function, radios, birds etc.

This course can be used to satisfy the (old) Gen Ed categories of Science of the Physical Universe or Empirical and Mathematical Reasoning, and can also count toward the Study of the Past requirement. It is my aim to continue the course into the revised version of General Education.

Note: This course should not be confused with Astro. 2, Celestial Navigation. Although there is some overlap, this course is intended to present a broad spectrum of physical phenomena and the historical basis of many concepts.

Note on math: only fairly simple mathematical operations will be used, but we want you to carry them out long-hand â€“ addition, subtraction, multiplication, and long division. No calculators. Part of this is to carry only as many significant figures as are appropriate given the magnitude of uncertainties. Many solutions will be graphic in nature, which is why we ask you to bring compasses (drawing and magnetic), protractors, and rulers to lecture.

Instructors

Professor: John Huth

236 Lyman Laboratory

huth@physics.harvard.edu

617 495 8144

Office Hours Tuesday 12-2, and by appointment

Head TF: Mark Gabrielson

mjgabrielson@gmail.com

Office Hours: Wednesdays 1700-1830, Lamont Library CafÃ©

TFâ€™s: Stephen Chan

Palfrey House

schan@physics.harvard.edu

Office Hours: Thursdays 11:45-13:45, LISE CafÃ© 2nd floor

Max Mulhern

maxmulhern@hotmail.com

Office Hours: Thursdays 16:15-18:15 Palfrey House (18 Hammond St.)

Course structure

Lectures:

Mondays and Wednesdays 2:30-4 PM, Science Center Hall A.

Nearly all of the course work is to be completed in notebooks that are available in the Coop as part of the course materials. Assignments are logged in the notebooks, which are turned in at the end of Mondayâ€™s lecture, and returned at the start of Wednesdayâ€™s lecture.

While some of the lectures are straight lecturing, we will have some breakouts to do exercises in the notebooks, and also students will be called on randomly to discuss some aspect of the material to the rest of the lecture.

No laptops, cell phones, or calculators are allowed in lecture. When this policy was implemented in the past, many students expressed gratitude for the lack of distractions from other students. I recommend a separate notebook from the assignment notebook to take notes in.

Bring protractors, drawing compasses, and rulers to lecture. I recommend pencils with good erasers as well. (See examples farther in this syllabus for examples)

Lectures will **not** be video-taped after the shopping period.

Sections:

Sections will meet starting the 3rd week of classes, and will be held Wednesday, Thursday, and Friday afternoons. In addition to consolidating material presented in lecture, introduction to assignments will also be carried out.

Basis of grade:

Assignments: There are 9 assignments total. They emphasize navigation and empiricism. In addition to this, we ask the students to write some reflection on the broader cognitive aspects of what they learned from the assignments. The assignments take place outdoors in large part. Some can be performed in groups â€“ we will let you know which ones are to be performed in groups and which ones done independently.

Many of the assignments are to be done outside. One assignment weâ€™ll do on a sailing vessel in Boston Harbor. One assignment on the stars will have a culmination on the roof of the Science Center at night,

with a star quiz using visible stars. Because of timing, students will have to work these exercises into their schedules.

Nearly all the assignments are written up in a single notebook by all students which gets turned in at the end of Mondayâ€™s lecture and returned at the beginning of Wednesdayâ€™s lecture. At the end of the course, students will keep the notebooks.

Late assignment policy: Starting with assignment 3, the following policy goes into effect for late assignments. If it looks like you won't be able to turn in an assignment in lecture on time, e-mail your TF by noon on the day the assignment is due to work out an alternate arrangement. Unexcused late assignments will be collected a week later, and 50 points (out of 100) are deducted. Part of this is to keep from having assignment dribble in.

In addition to the worked parts of the assignments, we include reflective questions that touch on the broader meaning of the cognitive aspects of navigation.

Class participation:

On shipboard, there are â€˜watchesâ€™, where sailors are assigned tasks and expected to carry out the tasks faithfully. The lives of the crew members depend on it. In some ways, we make class participation something of a microcosm of this concept.

We expect you to attend both lectures and sections, and actively participate. Part of this is to increase engagement, but it also provides us with feedback on which concepts are unclear. We will take attendance in section, but not in lecture. Participation as an element of the grade is ascertained by both attendance and engagement in discussion, particularly in section. For lectures, this is based on the random calls described in the next paragraph.

During lectures, we will randomly call on students to come to the front of the lecture hall and describe some aspect of the assignments. Typically, we wonâ€™t look for the â€˜rightnessâ€™ or â€˜wrongnessâ€™ of the description, but rather use this as a way of getting students and course staff familiar with each other. This also helps us assess which concepts students understand, and which ones they donâ€™t understand. The random nature of calling on students assures fairness, and encourages attendance. If you cannot make a lecture for some reason, let the Professor or your TF know ahead of time, if at all possible.

In some of the assignments, you have to show up and participate outside of normal classroom hours â€“ e.g. the roof of the Science Center for the star exercise, the sailing vessel Adirondack for the navigation on water exercise.

Quizzes

There will be some quizzes on the locations of stars in the sky in section as a prelude to the assignment on the roof of the Science Center.

Bok Center Video

Groups of students schedule a 3-5 minute video taping session with the Bok Center on the broader concepts touched on in the course - including navigation as a cognitive process, uncertainties, mindfulness, and automation bias. This is due by the end of reading period.

No midterm exam

Final exam:

The final exam will be completed in the notebook. It is, effectively, a long navigational exercise that reprises most of the concepts taught in the class.

Grading algorithm

There is no perfect algorithm to demonstrate competency in learning the topic, but we will use the following linear weighting. Each aspect will be scored out of 100%.

Final number (out of 100) = 0.6*(Assignment average) + 0.05*(Attendance +Participation)+0.05*(Quizzes) + 0.1*(Video) + 0.2*(Final exam)

We endeavor to reach the typical grading scale of an A is 92-100, A- is 90-91, B+ is 88-89, B is 82-87, B- is 80-81, C+ is 78-79, C is 70-77. We reserve the right to shift the scale downward â€“ that is to say, making

it easier to get a higher grade.

Materials

Many of the readings will be out of the book, â€œThe Lost Art of Finding Our Wayâ€. In addition to this, we will post a large number of supplemental postings. There is also a practical online hyperlinked guide to simple navigation with a map/chart, and compass. The book is available at the Coop, along with the standard notebook we expect people to use. All assignments and work supporting the assignments are to be done in a computational notebook, also available at the Coop.

The Lost Art of Finding Our Way. Computational notebook, 4x4 to the sq. in.

In addition to the above, youâ€™ll need some drafting tools also available as part of the course package at the Coop. You'll need a magnetic compass, which, for bureaucratic reasons are not available at the Coop. You'll have to either order them online, or go to the EMS store in the square to purchase one. You should get one with a clear baseplate, like the in the drawing below. A Suunto A-10 is a common an inexpensive model that students have used in the past.

Tools: drafting compass. Magnetic compass.

Protractor

Ruler with centimeter and inch scales.

Although not necessary, I also recommend a set of parallels, which can be found at Staples, or simply ordered online.

Parallels

Week 1

Lecture 1: Wed Aug 31st Introduction

Reading: Chap 1,2, Handouts on uncertainties, dimensional analysis, significant figures, how to organize the assignment notebook.

Week 2

Lecture 2: Wed Sep 7th Maps in the Mind

Reading: Chap. 3, 4; Handouts on dead reckoning (1 and 2), angular measures

Assignment 1 available Wed. Sep 7th.

Sectioning by the end of the week

Note: Much of the details of managing dead reckoning throughout the course can also be found on the following website:

http://artofwayfinding.blogspot.ch/2014/11/on-go-navigation.html

You can follow the hyperlinks.

Week 3

Lecture 3: Mon Sep 12th On being lost, statistics

Lecture 4: Wed Sep 14th Distances and dead reckoning I

Reading: Chap. 5,6; Handouts on correlations, small angle approximation.

Assignment 1 Due at Lecture Mon Sep 12th, returned Wed Sep 14th

Assignment 2 available Wed Sep 14 â€“ paces, angular measures, statistics

Start sections this week

Note: Assignments, the Final exam, and other student work will be submitted for grading within each

individualâ€™s note book. Note book drop-offs will generally be on Mondays at Lecture, and note books will be returned generally the following Wednesday at Lecture. Alternative arrangements should be discussed with and cleared by your TF in advance.

Week 4

Lecture 5: Mon Sep 19th Distances and dead reckoning II

Lecture 6: Wed Sep 21st Maps and compasses I

Reading: Chap. 7; Handout on topographic maps, blog section on triangulation

Assignment 2 Due at Lecture Mon Sep 19th, returned Wed Sep 21st

Assignment 3 (map) available Wed Sep 21st â€“ magnetic compasses, triangulation.

Some exercises to test skill at reading topographic maps can be found at this website:

http://education.usgs.gov/lessons/map_mysteries.html

Week 5

Lecture 7: Sep 26th Maps and compasses II, Stars I

Lecture 8: Sep 28th Stars II

Reading: Chap 8; Handout on star compass, star heights, star chart, stars to memorize, grid, sample quiz 1

Assignment 3 Due at Lecture Mon Sep 26th, returned Wed Sep 28th

Assignment 4 available Wed Sept 28th â€“ walk from Chapel to CfA

Assignment 5 available Wed Sept 28th â€“ Adirondack exercise

Note: Assignments 4+5 are done concurrently and turned in at the same time on Oct 24

Week 6

Lecture 9: Oct 3rd Stars, Sun I

Lecture 10: Oct 5th Sun II, Moon

Reading: Chap 9; Handout on equation of time, declination of the Sun

â€˜Adirondackâ€™ Trip Option 1 â€“ Tuesday, Oct 4th

'Adirondack' Trip Option 2 - Thursday, Oct 6th

'Adirondack' departs from Rowes Wharf at 1:30 PM

Star Quiz 1: administered in Section

Week 7 (Columbus Day is Oct 10)

Lecture 11: Oct 12th Sun, Moon, Calendar

Reading: Chap 10, details about latitude and longitude

'Adirondack' Trip Option 3 - Thursday Oct 13th

'Adirondack' departs from Rowes Wharf at 1:30 PM

Star Quiz 2: administered in Section

Week 8

Lecture 12: Oct 17th Latitude and longitude I

Lecture 13: Oct 19th Latitude and longitude II

'Adirondack' Trip Option 4 â€“ Tuesday Oct 18th

'Adirondack' departs from Rowes Wharf at 1:30 PM

Assignment 6 available: First week of sessions for Star Identification

Science Center Roof

Observation dates and times to be announced

Week 9

Lecture 14: Oct 24th Latitude and longitude III, Weather, In Class Exercise

Lecture 15: Oct 26th Weather

Reading: Chap11

Assignments 4+5 both due at Lecture Mon Oct 24th, returned Mon Oct 31st

Assignment 6 available: Second week of sessions for Star Identification

Week 10

Lecture 16 Oct 31st Weather II

Lecture 17 Nov 2nd Waves

Bok center video assignment

Reading: Chap. 12

Assignment 7 available Mon Oct 31st: latitude and longitude by solar observation

Assignment 6 available: Third and final week of sessions for Star Identification

Note: Assignments 6+7 are done in parallel and turned in at the same time

Week 11

Lecture 18: Nov 7th Tides

Lecture 19: Nov 9th Ocean currents

Reading: Chap 13,14

Assignments 6 and 7 both due at Lecture Mon Nov 7th, returned Wed Nov 9th ***Note: Assign. 7 due date shifted to Nov. 14***

Assignment 8 available Nov 14th â€“ Weather observation

Week 12

Lecture 20: Nov 14th Ship design

Lecture 21: Nov 16th Sails

Reading: Chap 15, 16

Week 13 (Thanksgiving break starts Wed Nov 23)

Lecture 22: Nov 21st Planets, birds, planes, ocean going vessels

Week 14

Lecture 23: Nov 28th Radio triangulation

Lecture 24: Nov 30th Wanderers: planets, planes, birds

Reading: Chap 17, 18; handout on radio triangulation

Assignment 8 due at Lecture Mon Nov 28, returned Wed Nov 30th

Assignment 9 available Wed Nov 30th â€“ radio triangulation

Week 15

Note: Reading Period December 3-9

Lecture Hall: December 5th TFs Review and Q&A

Assignment 9 due at Lecture Hall Mon Dec 5th, returned Wed Dec 7th

Videos due by end of reading period

Note: Final Exam Period December 10-20

Grades will be available at end of final exam period.