NRC497MS/ECO697MS & PPA497MS/697MS

Applications in "Open Source Science" and Innovation: A "Flipped", Service Learning, "Makerspace" Course

Fall, 2015 – draft version

Lead Instructor\facilitator: Professor Charlie Schweik, Eco, CPPA

Co-Instructors:

Professor Steve Brewer – Biology
Professor Rick Peltier – Public Health
Professor Paula Rees - Engineering
Professor Alex Schreyer – Building and Construction Technology

Meeting times:

- **Formal class session**: Mondays 2:30-5:00 pm -- Biology Computer Resource Center, 315 Morrill Science Center, Building III South
- **Open (optional) work session:** 1.5 hour Lab session: Location\Time TBD once class begins, but possibly Friday afternoons at Amherst Media's makerspace open hours.

Textbook/lab fee: No text book requirement, but students are expected to contribute up to $50 toward the purchase of equipment for their selected projects.

Class Summary:

Recently there have been tremendous advances around open source and low-cost technologies that have implications for environmental science, and environmental management. Prominent examples of this can be found in the recent "maker movement" and the creation of community-based "makerspaces" (http://makerspace.com) and the emergence of groups like the Public Laboratory for Science (http://PublicLab.org). These new advances in open source hardware technologies have some real promise (and some potential pitfalls or concerns) for government and nonprofit organizations doing work in environmental management.

In this class, we will be focusing on the idea of developing "open source science" projects that utilize low-cost environmental technologies, often for use in environmental justice situations. Interdisciplinary students will meet and form teams to identify an environmental monitoring project they would like to design and implement. Some of these projects will build upon open source hardware technologies such as the Ardunio microcontroller, 3D design and printing, or other relatively low cost open science equipment (see for example, PublicLab.org). After these "open source science" projects are identified, we will purchase needed equipment and then use weekly class sessions for roll-up your sleeves working sessions. In these sessions you will (1) utilize online educational material to learn the technologies needed to build your device; (2) work iteratively, to develop and test a project prototype; and (3) (hopefully) develop a working system. Possible projects are: helium balloon-based or unmanned aerial vehicle photography, a GPS collar for tracking wildlife, a water pollution detection instrument, an open source research submarine to support fish ecology research, an air quality measuring instrument, a receiver to receive data from the emerging "Outernet" satellite system, or some 3D design and printing-related idea. Students who are in less technical fields are invited to propose a project researching the social or public policy implications of one of these technical project ideas. A second component of the class, open to students with an interest in "service learning" will be to design a project with a teaching component for use in an after-school program held at Amherst Media, or possible "science club" being offered in the Amherst middle- and high-schools.

Finally, students will document their projects through real-time "research notes" on the open science, PublicLab.org website.

Open Source Science Project Examples

Fig 1. PublicLab.org's Helium balloon aerial photography

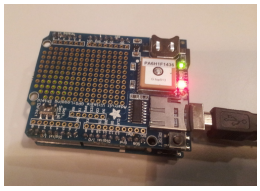

Fig 2. Arduino GPS Dog/Wildlife Tracker Collar

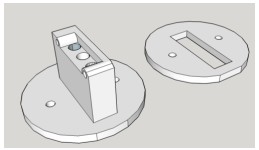

Fig. 3. 3D Designed container for a water pollution monitor

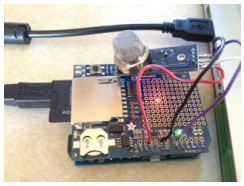

Fig 4. Arduino ozone air quality monitor

Fig 5. Quadcopter landcover mapping

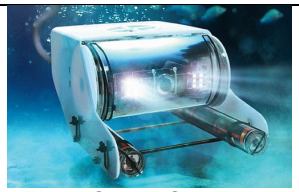

Fig. 6 OpenROV: Tethered Research submarine for fish ecology research

Fig. 7. 'Outernet' data receiver (see https://www.outernet.is)

Fig. 8. Experiments in PublicLab's desktop spectrometry

IMPORTANT NOTE: Policy or "social science" projects that complement any of the above are encouraged! Two examples:

1) Quadcopter policy - if a team is working on an aerial phtotography project with a quadcopter -- we'll have one this year – I'd like a student to research what the current laws are around this, and investigate the pros and cons of these technologies, moving us potentially to some guidelines for research use.

2) Outernet – This is a private firm that has satellites deployed that are streaming open access data to the world. The challenge is what content to include. This is just starting up; so in this project students could help implement one or more UMass "outernet content-athons" to help them build their global, open access signal.

This year, team project options include:

- Fish ecology research with a small, tethered submarine, called "OpenROV" [1], building on last year's project by Dan Smogia and Leif Dickinson (Fig. 6 above)

- Landcover mapping using an unmanned aerial vehicle and camera (UAV, probably a quadcopter), and the public policy issues around such technologies, or helium balloon aerial photography project (see PublicLab.org) (Fig. 5 above)

- Arduino or lillypad-based GPS collar and mapping for wildlife tracking (Fig. 2 above)

- Arduino-based water monitoring project (Fig. 3 above)

- Build and test 'Outernet' data receiver (see https://www.outernet.is/en/) -- http://outernet-project.github.io/orx-install/, and a project related to holding an "Outernet content-athon" on the UMass campus. Outernet is a new company trying to stream data to the 2/3rds of the world that have no access to the Internet. (Fig. 7 above)

- Air quality monitoring sensor and deployment building from last year's project by Liz Pomgrantz (Fig 4 above)

- An application of PublicLab.org's open source "desktop spectrometer" to investigate whether it can distinguish invasive species plants from other plants using light reflectance. (Fig 8 above)

- Building system and environmental sensing solutions (using an arduino device, possibly)

- Some 3D design/development project (e.g., designing tools or devices) (Fig 3 above).

- *These are just some of the team opportunities*! We seek creative students who want to come up with their own project ideas!

Expectations are that students will work approximately seven to eight hours/week outside of the three hours of weekly class meetings.

Prerequisites and expectations: While this is a natural class for Computer Science/Informatics, Engineering, or Information Technology minor students, it is also meant to be interdisciplinary and is designed and applicable to students interested in Environmental Science, Natural Resources Conservation, Public Policy and Administration, Biology, Public Health, Sustainability or Building and Construction Technology/Green Building. 5-college (Amherst, Smith, Hampshire, Mt Holyoke) students are urge to join as well! Each project team will need their own laptop. Some funding will be available to purchase project equipment, but in lieu of the no textbooks, students will be expected to contribute to their project equipment needs (no more than $50).

(Note: We are also working on getting this class assigned an "SI" designation. **No promises**, but with some luck we hope to have this done by Fall 2015).

Contact Charlie Schweik (cschweik@pubpol.umass.edu) if you have questions.