Digital pedagogy in three parts: screencasting, course blog, remote guests

Course: Bio-aerial Locomotion (ENG)

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Summary

The digital pedagogy in my course titled "Bio-aerial Locomotion" stands on a tripod. One leg is class presentation, recording and online dissemination. The second leg is a course blog, with student assignments publicly available online. The third leg is a program of distinguished invited speakers participating in the course via Skype.

The course is one of a set of ten modules in the College of Engineering's offerings under the *Introduction to Engineering* umbrella. All incoming freshmen have to choose two modules, according to their interests, with topics varying from mechanical design, photonics, biomedical engineering environments, among others. This module is aimed at motivating the subject of bio-inspired engineering through the study of the way animals move in the air by either falling, gliding, or flying.

Class presentations are based on electronic slides with ample embedded media, and the use of digital inking for on-screen annotations. This format for presentation is not only interactive and engaging, but also permits the use of very simple and inexpensive means of lecture capture and dissemination via screencasts. The course makes use of BU's page in the iTunes U service, and has been the Top Collection on BU's space throughout the Fall 2011 semester. At the time of writing, the first 15 tracks on the Top Downloads list of BU's iTunes U channel are Bio-Aerial Locomotion videos.

The course blog is co-authored by the instructor and students of this course. Students are required to post their writing assignments to the blog, which is open in the public internet. This has two effects: (1) the instructor is able to motivate them to learn about and avoid plagiarism by appealing to their sense of public persona, and (2) the students express themselves in a more casual, comfortable tone than if they were writing formal essays; they are also able to use media-rich formats. The final ingredient, distance invited speakers, has been a great hit with the students. They are inspired by discussing the course topics with leading experts in a variety of fields in this inherently inter-disciplinary course.

Screencasts

Digital inking on electronic slides combines the benefits of presentation software with traditional handwriting-based classroom presentation. The electronic slides allow rich graphics and embedded media, while on-screen annotations add the benefits typical of chalkboard lectures: interactivity (via spontaneous addition of material) and a comfortable pace for explanations and note-taking. For an engineering course, digital inking has the added benefit of being more flexible than static slides for using mathematical notation and problem solving.

Moreover, the use of digital inking allows a very simple and inexpensive means of lecture capture: screen video. Traditional lecture capture is based on live video, which involves additional human resource (camera operators) and post-processing time for video editing. On the other hand, screen video capture only requires an inexpensive piece of software installed in the laptop used for class delivery, and post-processing is minimal or zero. Thus, we have a very inexpensive means of providing self-study materials and post-lecture replay and support: the *screencast* of the annotated slides.

The video material is diseminated to the students (and the public) via the iTunes U service, and hosted on Apple's servers. Students can view the video online and replay the complete lecture or portions they feel need recollection. They can download the video and sync with their mobile devices (such as iPod), thus allowing replay on idle times like commuting, etc.

The course on iTunes U can be previewed at:

http://itunes.apple.com/us/itunes-u/bio-aerial-locomotion-ek131/id464937253

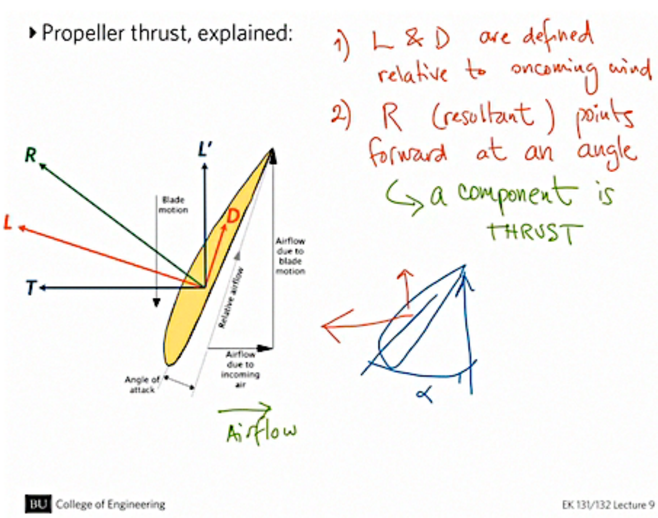

***Figure 1**. A sample slide, annotated with digital ink during lecture.*

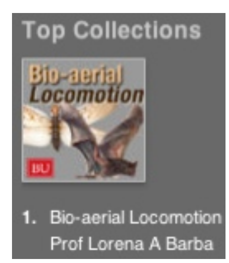

***Figure 2**. Screenshot of BU's iTunes U page, Top Collection, retrieved on 12/04/11.*

Course Blog

Students have writing assignments for this course that they must post on the course blog, open to the public internet. One motivation for blog assignments was advice that I read online about creating assignments that are less susceptible to cheating, as an alternative to policing students[1]. Public projects or public assignments encourage most students to behave correctly, avoiding plagiarism, simply by appealing to their sense of public persona on the Internet. This was supported by in-class discussion of the meaning of plagiarism and the College's academic conduct policy.

The main reason for having writing assignments in the first place is that the College's *Introduction to Engineering* modules are required to address four outcomes: ethics, communications, societal context and contemporary issues. The course blog was the venue I chose for the communications exercises, with the ethics component coming in also via class discussions about copyright, Creative Commons, and fair use for the Internet.

After designing the course, with its blog taking a major role, I came across some evidence supporting the notion that students write differently online than they do in papers. In a course about learning on the Internet, the instructor had students contribute to a blog, and discovered *"something curious. Their writing online, at least in their blogs, was incomparably better than in the traditional papers."* [2] The author observed that online blogs are directed at peers, and students are driven to communicate better.

Although I did see a couple of lazy contributions, overall the writing assignments published by the students were interesting, well-written, and even witty at times. We used BU's WordPress blogging tool, which made it easy to add every student as "Author", and used comments on the posts for greater interaction and an opportunity for informal peer review. Commenting was encouraged by making it a part of the course participation grade.

See the course blog at: http://blogs.bu.edu/biolocomotion/

Distinguished guest speakers

We had six guest speakers during the semester: four of them Professors and two of them terminal PhD students. They connected via Skype, and we used the instructor's wireless lapel microphone to pass around for the students' questions to be audible on the other end. The Skype video was projected in the classroom, and the audio amplified via the classroom's PA system. The interactions were recorded via screen capture (like the lectures) and are available publicly on iTunes U.

Here is a list of the distance guest speakers:

1. **Prof. Steve Yanoviak**, tropical arthropod ecologist at the University of Arkansas at Little Rock — He discovered the gliding behavior of wingless ants, a totally unexpected discovery that originally appeared in *Nature*, and then grabbed attention in news media such as The New York Times, Canal+ (France TV), LA Times and even Ranger Rick (among others). His discussion with the students was summarized in my blog post of 11/05.
2. **Ardian Jusufi**, PhD student in the department of Integrative Biology, University of California Berkeley — He was the lead author of the paper presenting the air-righting reaction of falling geckos, which appeared in the *Proceedings of the National Academy of Sciences*.

3. **Prof. Jake Socha**, Engineering Science and Mechanics, Virginia Tech — An organismal biomechanist, he discovered and explained the gliding behavior of "flying snakes". His work has been the subject of a National Geographic channel program, articles in The New York Times, The Boston Globe, Discovery News, Voice of America and many more.
4. **Prof. Robert Full**, Department of Integrative Biology, University of California Berkeley — With an impressive list of high-impact discoveries coming from his lab (such as the secret of the sticky gecko feet), Prof. Full is a leading authority in comparative biomechanics and physiology. He is perhaps best known in the blogosphere due to his speaking appearances in several TED talks.[3]
5. **Yonatan Munk**, PhD student at the Department of Integrative Biology, University of California Berkeley, working with Prof. Dudley (below) and Prof. Mimi Koehl — His doctoral work involved the study of gliding ants, in paraticular how posture and morphology determine their stability and control, via both field work and lab experiments with dynamical models.
6. **Prof. Robert Dudley**, Department of Integrative Biology, University of California Berkeley — He is the world's leading expert in the evolutionary origins of flight, and flight maneuverability and flight performance in birds and insects.

Educational objectives and benefits

The target students of this teaching innovation are freshman undergraduates, who are "digital natives" and are comfortable in a media-rich and device-rich educational ecosystem.

Objectives

The objectives of these teaching innovations are:

1. Provide an interactive classroom experience via digital inking of media-rich electronic slides.
2. Capture lectures digitally by screen video capture software, distribute for replay and self-study, and public dissemination of course materials in the open courseware model.
3. Develop communications skills for the digital age.
4. Motivate the subject via remote guest speakers, giving access to top experts.

Benefits

Each component of the digital pedagogy program in this course has a number of benefits:

- Screencasting
  - high-quality projected images on electronic slides, with ample embedded media
  - interactive, spontaneous addition of hand-written material with digital inking
  - complete lecture is captured as video of the screen, with instructor's voice
  - low-cost alternative to live classroom video; virtually no post-processing
  - students can replay and recall, and view lectures they have missed
  - public dissemination of course media via iTunes U
- Course blog
  - public writing projects for plagiarism avoidance without policing
  - medium encourages natural writing style, potentially better quality than papers
  - students learn skills for communicating online, including use of Creative Commons images

- Remote guest speakers
  - students hear from leading experts in the field
  - exposure to the excitement of scientific discovery
  - complement the instructor in an inherently interdisciplinary course

Course syllabus

Module description

Human-designed flying devices are just over 100 years old, which is not very much in historical terms, and much less in evolutionary terms. In nature, flight has evolved quite efficiently, and at least four times (insects, pterosaurs, birds and bats). Moreover, many biological organisms maneuver in the air effectively, without flying, per se.

In this course, we discuss a selection of interesting cases of bio-aerial locomotion of increasing sophistication: from falling and parachuting, to gliding and flying. When falling, geckos are able to right themselves turning their body in mid-air, and always land safely on their feet. Some species of snakes can glide to the ground while slithering their body to adjust their shape; and samaras (winged seeds like the maple seed) slow their descent as they spin, so the wind will take them farther aiding dispersal of the tree species. Many birds can boost their glide by efficiently exploiting thermal currents in the air, and small birds and insects can hover in the air via flapping flight. All these examples, among others, are inspiring engineers today to design new devices suchas micro-air vehicles and robots that perform impressive feats. In this course, you will get a glimpse of the modern activity of bio-inspired engineering, in particular in its relation to the fields of aeronautics and robotics.

Course aims

This course aims to motivate the subject of bio-inspired engineering, characterized by seeking examples in the biological world of the desired function in the engineered creation. In particular, we seek examples of aerial locomotion in the increasingly sophisticated forms of: falling, parachuting, gliding and flying.

Learning objectives

Students will …

1. become familiar with examples in the biological world of effective falling, parachuting, gliding and flying;
2. gain basic understanding of how engineering analysis can be used to study these examples of aerial locomotion and extract the principles that underlie them;
3. learn about the basic forces involved in aerial locomotion and flight;
4. think creatively about adopting the principles of bio-aerial locomotion for engineering design of devices that fall, glide, or fly mimicking nature;
5. gain experience documenting and presenting engineering principles observed in nature.

Lecture topics

1. Falling — Air-righting reflex in house geckos; angular momentum of an object; conservation of angular momentum; air-righting simulations. Engineering inspiration: the RightingBot.

2. Parachuting & gliding: diversity in aerial locomotion — Graphic catalog of gliding animals: gliding frog, "flying lizard", snakes, "flying fish", "flying squirrel", colugo. Feature: the canopy ants.

3. Basic science of flight — Wing carrying capacity; wing loading. The Lift force: role of angle of attack. What produces lift: Coanda effect; cambered airfoil; "equal-time" explanation wrong. Bernoulli's principle. Wing loading for birds: larger birds have to fly faster. The Great Flight Diagram (GFD). Deviations from the GFD: the Boeing 737; human-powered flight and the Gossamer planes; swifts and swallows. Changing wing geometry to vary speed. The peregrine falcon. Birds landing maneuvers.

4. Swifts — How swifts vary sweep angle, and the effect on coefficient of lift and drag. Lift vs. Drag ratio. Different measures of glide performance of swifts with varying sweep angle. Morphing wings; other uses: guillemot swim vs. fly postures. Engineering inspiration: RoboSwift.

5. Gliding snakes — Complex aerodynamics; rib action and gliding posture, turning maneuvers, glide angle. Snakes' "airfoil shape", aerodynamic study.

6. Flapping: powered flight in birds, bats and insects — Introduction: physics of propeller thrust; propeller twist. Flapping motion: wing-stroke path, the downstroke, the upstroke and features dependent on flight speed, feathering and flexion of the wing. Engineering inspiration: Festo's SmartBird.

7. Hovering — Horizontal wing-tip paths; hummingbird wing motion during hover and in forward flight at different speeds. Hummingbird wake structure. Hovering wing strokes; features of the upstroke: wing rotation along its length and camber reversal. Amount of lift generated on the upstroke for hummingbirds and insects. Windhovering.

8. Leading-edge vortex — RoboFly and the visualization of leading-edge vortex (LEV) in early studies; different structures of LEV; examples: butterflies, dragonflies; comparison with delta-wing vortices. LEVs in swifts during fast gliding, nectar-feeding bats, and maple seeds. Engineering inspiration: Lockheed Martin's Samarai UAV.

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[1] The story behind this idea is interesting. In July 2011, an NYU professor published in his blog what became a very controversial essay (and naturally went viral), titled "Why I will never pursue cheating again." In the conclusions of the essay, the author advocated for public projects, with the note that "The risk of public embarrassment is a significant deterrent." The author's two other recommendations were peer reviewing and competitions. Although the post was later taken down, at the university's request, there are several copies in aggregators and other sites.

[2] "Collaborative Learning for the Digital Age", Cathy N. Davidson for The Chronicle of Higher Education, Aug. 26, 2011. http://chronicle.com/article/Collaborative-Learning-for-the/128789/

[3] His TED talk of February 2009 titled "Learning from the gecko's tail" has over 300,000 views: http://www.ted.com/talks/robert_full_learning_from_the_gecko_s_tail.html

Appendix

Details of the technology used

The technology requirements for digital inking and screencast production are listed in the table below. The only non-standard items are the graphic tablet and screen capture software. In addition, a USB-powered microphone is used to improve the quality of the recorded audio with the instructor moving around in the lecture room. The overall cost of these items adds to just a few hundred dollars.

Table 1. *Hardware and software requirements*

Class preparation and presentation	In the classroom	Post-lecture screencast delivery
A laptop computer, slideware app: **MacBook Air** & **Keynote** Graphic tablet: **Wacom Intuos 3** On-screen annotations app: **OmniDazzle**	Data projector and laptop. Screen capture software running on the laptop: **iShowU**. Wireless USB mic: **RevoLabs xTag**	Video editing software: **Quick Time Pro v.7.7.** Dissemination via **iTunes U**, see: http://www.bu.edu/tech/comm/audiovideo/itunes-u/