As a historian of science teaching at a polytechnic institute, I like to focus on these questions: How has knowledge changed over time? Under what circumstances have the unique actions or belief systems of individual thinkers made a new set of ideas or practices in the sciences suddenly conceivable or even feasible, even though they had not previously been imagined or taken seriously? By exploring such questions, which highlight historical contingency, all students can gain a valuable critical thinking tool that is very different from most forms of quantitative reasoning. Although my students at WPI generally focus the bulk of their undergraduate studies on acquiring technical mastery within a specific field of science or engineering, when I expose them to the richness and complexity of historical sources and analytical interpretation approaches, specifically framed in order to help them gain some sensibility about how change ever happens, I believe they become better equipped to be agents of discovery and innovation in their own careers.

My experience co-teaching the interdisciplinary *Power the World* Great Problems Seminar at WPI together with a colleague from Mechanical Engineering (2007-09) was what inspired me to bring a project-based learning experience to all of my courses, including those within the history curriculum. Project-based learning turns out to be an especially effective means of inducing technical students to overcome preconceived, secondary-school reinforced expectations that the study of “history” is merely concerned with the accurate recall of lists names and dates. Below, I provide a brief description of some of the activities I have tried at various levels in my history instruction.

### In-class small-group activities for larger intermediate-level “lecture courses”

For all my 50 student classes, I build in five 1-hour blocks of class time during the term, which I devote to a series of group discussion activities centered on analyzing the reading assignments in class together. I divide the class up into groups that have no more than 5 members, and I assign 15% of the course grade to the writing assignment that is based on one of the group members' discussion notes from one of those sessions. Being the note-taker is a rotating responsibility, so that everyone gets one turn during the term to be the Discussion write-up author. All the discussion write-ups gets posted on the class web site, and all of them are considered "notes" for the sake of my "open notes" exam policy.

Here is my pedagogic reasoning: this small group discussion structure rewards people for doing the reading scrupulously, but also for sharing what they understand, and learning it more deeply by trying to articulate what they think to their classmates, with a lower performance pressure than having to be grilled by the instructor in front of the whole class. This approach amounts to treating “understanding the reading assignments” as a “project” shared among small groups of students; and by doing so, everyone in the room has a good chance to participate actively as learners in at least those five of the class meetings (and my class participation grade – another 10% of the course grade - is heavily weighted to encourage attendance on those five discussion group days in particular). Studying for exams then involves reviewing not only one’s own notes, but
also examining what other groups of students in the same class thought about the readings as well (which encourages a greater awareness of the need for critical thinking when faced with alternative interpretations).

During those small group discussions, I float around the room eavesdropping, kibitzing only if a group seems confused or "stuck" on a question (I hand everyone a set of guiding questions for every discussion), but otherwise I try not to get too involved in directing the course of any particular group's thinking. I grade the papers that result as if they were "history papers." Note that I only have 10 papers to grade in any given batch. So, I have time and energy to provide detailed critical feedback aimed at cultivating good writing, the presentation and appropriate citation of evidence, a sense of logical argument (and in this case, debate between various positions), all of which are factored into the grade. I also insist that the authors give individual attributions to their classmates for all the points raised (both to highlight the sense that an actual conversation among different thinkers took place prior to the writing of the paper, and to give myself a better window into who are the more fertile/insightful/sophisticated thinkers and just how energetically individual students are working to interpret the course materials).

**How I support the cultivation of a “project-based learning community” feeling in seminar courses**

For meetings of courses with fewer than 20 students enrolled (upper-level history topics seminars), I structure each class meeting that does not involve a scheduled film showing so that students can take turns performing more active ways of supporting each other’s learning. The seminar course becomes a learning community, and the subject matter we are investigating together becomes a shared “project” experience. Here is how I organized the roles in my most recent seminar: two Presenters were lined up in advance to prepare brief reports on distinct scholarly source materials that they have researched to supplement the day’s required reading assignment. By the time class begins, each of the presenters would have downloaded a pdf of the source that they had found and read carefully, which they presented to the class orally (5-10 minutes). Each presenter subsequently posted the pdf on the course web site’s discussion board by the end of that day, and provided both a properly formatted Chicago Style footnote citation and a properly formatted Chicago Style bibliography entry for the source. A 2-3 sentence long annotation also indicated what interesting historical question or issue the source illuminated, and outlined the presenter’s thoughts about what was distinctive about the author’s research approach or response to this question.

Another pair of students were assigned to serve as a team of Discussion Leaders for each class. They prepared a set of open-ended discussion questions (and perhaps a creative activity idea) with which to guide the class through its analysis of all of the assigned readings for that day. If they so desired, the discussion leaders were empowered to be quite creative about how we spent our class time together (a structured debate, a game, some kind of hands-on work activity, etc., might be introduced) – anything was possible, so long as it helped to illuminate the subject matter that we were trying to understand, from that day’s readings.
For each seminar meeting, one student (the Scribe) would take responsibility for composing a detailed account of that day’s class meeting, based on a comprehensive set of notes taken during class, subsequent critical reflection, and careful reconnections of the information covered during the class to specific pieces of evidence provided in the assigned readings. Another student (the Web Crawler) would take responsibility for searching the internet in real time for fact-checking or to find any other useful materials that pertain to the ongoing class discussion. The web crawler kept a running record of these valuable URLs, and compiled a critical summary of the best sites/most important pieces of information that were found during the class meeting. Assigning these two roles freed everyone else up to fully “present” in the actual seminar discussion. Ordinarily, nobody but the Scribe needed to take notes. Nobody but the Web Crawler was allowed to search the internet (or operate their cell phones/personal electronic devices) during class. The “Scribe Notes” and “Summary URL Evaluation” papers for each class meeting were posted within 70 hours of the class on the course website for all class members to be able to consult and/or review.

Capstone projects

The Humanities and Arts requirement capstone experience (the “inquiry seminar”) has provided a particularly excellent setting to bring together my efforts to infuse project-based learning into historical studies at WPI. In my inquiry seminars, I seek to provide a distinct and rich experience of what it is like to belong to an advanced scholarly learning community of historians of science and technology. By treating my students like “fellow investigators of historically interesting questions,” I prepare them to pursue profound research and writing as members of a collegial team, not only for the sake of their HUA requirement capstone projects, but more importantly as preparation for whatever real-world investigations they may join in the future.

For their Humanities and Arts inquiry seminar project’s final product, my students typically collaborate to produce a collection of jointly-written research papers in history, as well as individual critical book reviews. I compile all this work into a “facsimile” of a professional journal issue in the history of science and technology. I have found that collaborative historical research and writing helps non-history majors to emerge with an appreciation for why historical argumentation is necessarily nuanced. The interpersonal process of inquiry and small group conversation encourages students to assemble a plausible answer to a research question even when they lack access to all the evidence one might find desirable, and of distinguishing shades of gray within that answer rather than imposing a rigid or dogmatic black and white interpretation (a problem I often encountered when advising mostly engineering and science majors to pursue individually-written history research papers).

I have explored a variety of topics within these inquiry seminar groups: the History of the Environment, Technology in the World, Global Expedition Science, the History of Geography and Mapmaking, Waterways History, Democracy and Science, and the Space Race Years. As in my regular history of science and technology course offerings, I shift the focus of investigation from one seminar to the next to inform and update my own research interests, and to encourage students to always be probing new questions and topics that have not been exhausted by their classmates from
preceding years. My seminar on the history of geography and mapmaking, for example, entailed a generous temporary loan of historical maps from Clark University’s collection to the WPI library’s archives, and resulted in papers and beautiful project posters. Providing this experience of hands-on scholarly engagement with actual historical artifacts allows me to coax students to integrate their knowledge of geography, philosophy, art, and literature with history, creating a climate of interdisciplinary investigation, from which all the students could benefit.