Bridging the Gap: a Co-taught Field Course with Integrated History and Civil Engineering Content

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This paper describes an innovative approach to the integration of social science and engineering content within the context of a field-based course. The class, titled “Oregon Bridges,” combines instruction about both the history of the construction and maintenance of major bridges in Oregon and the fundamental engineering design principles of bridge building. Students participated in a nine-day field trip along the Oregon Coast and the Columbia and Willamette Rivers, followed by classroom instruction and development of a portfolio of the bridges visited. The central theme of the class is the life of the bridge engineer Conde McCullough, best known as the designer of the major bridges on the Oregon Coast [4], and his continuing influence on the design of bridges in Oregon.

The class was co-taught by two faculty members, one from history and one from civil engineering. The design and execution of the course was a combined effort, with a unified set of readings and integrated instruction that exposed students to multiple viewpoints on the subject. The central goal was to provide civil engineering students with a broad perspective on the factors that influence engineering design, going beyond the purely technical to explore issues associated with aesthetics, place, politics, and economics.

This paper describes the class structure and content, as well as issues raised by the unique structure of the field portion of the class and problems encountered during planning and execution. A thorough discussion of course assessment is also included, based on student surveys and the achievement of learning objectives. Finally, we discuss the place of the course within the context of the major outcomes-based general education reforms now being implemented at the Oregon Institute of Technology as well as other civil engineering curriculum drivers like the ASCE BOK and ABET outcomes.

Background

Oregon Institute of Technology promotes hands-on practice-oriented learning. The Humanities and Social Sciences department has developed many practical program-focused courses to encourage students who enroll at Oregon Tech to engage methods of study in history and the humanities (examples include History of the Electric Grid, History of the Professions, Engineering Disasters, and Technology, Society, and Values). The Civil Engineering department at Oregon Tech has a strong laboratory component in its curriculum with a majority of programmatic courses including a laboratory. Given the motivations of these two departments and mutual interest of the project faculty in bridges, and Conde B. McCullough (Figure 1) in particular, the faculty identified the potential for a field course to tour important Oregon bridges. Emphasizing those constructed to complete the Oregon coast highway, the course brings the history of these bridges together with their design and construction details. Changes in bridge design practice were discussed as an analog to the development of civil engineering more generally.
The course faculty received a small grant from the university’s Commission on College Teaching to visit bridges intended for the course and to develop the course further. Beginning from this simple idea, over the following year the faculty developed the course to tell the story of bridge construction in Oregon and connect it to bridge design and technological developments in the United States in the 20th century.

Introduction
The first offering of the Oregon Bridges course consisted of a nine-day field component conducted in early September prior to the start of fall classes. Eight civil engineering students and two faculty travelled in two minivans from the campus in Klamath Falls, to the southern Oregon coast, to Portland, Astoria, and the Columbia River highway and back south to Klamath Falls. A detailed itinerary of this trip is included in the appendix and a map of the route is included in Figure 2.

The breadth of bridges visited was impressive, including fixed and movable spans of nearly every type and both highway and pedestrian bridges dating from 1914 to 2016. Students were treated to the first reinforced concrete bridges constructed as Conde McCullough served as state bridge engineer, a modern example of a stressed ribbon pedestrian bridge by Jiri Strasky, and Precast/Prestressed Concrete Institute award winning post-tensioned box girders, all in the first day. Once on the coast, the group visited McCullough’s five signature spans constructed during the depression era, with many of them benefitting from the Oregon Department of Transportation’s (ODOT) active cathodic protection program. These were interspersed with recently constructed bridges designed to withstand the magnitude 8+ Cascadia subduction zone earthquake and the effects of the salty coastal environment with design lives of 120 years. The range of aesthetic and technical treatments on display in Oregon’s coastal bridges provided a basis for discussions of architecture, bridge design considerations, bridge management decisions, bridge load and condition rating, and historical bridge preservation. ODOT bridge inspectors, historians, and field staff met with students at various locations, further enriching the experience with practical and historical detail.
Upon reaching Tillamook, the group traveled inland to Portland and was able to explore the most diverse set of bridges per river mile in the United States [3]. The many movable bridges in Portland vary in their function and include the world’s only double-lift vertical lift bridge and the longest span Rall-type bascule bridge in the world. Portland also boasts the world’s first passenger-vehicle-free bridge catering solely to bicycles, pedestrians, and public transit. As an example of how bridges serve an urban environment and support a healthy multimodal transportation network, Portland’s infrastructure is unparalleled.

The group traveled northwest from Portland to Astoria to see the longest bridge across the Columbia River as well as other examples of cantilever truss, tied arch, and coastal timber pile bridges. Travelling east along the historic Columbia River highway, the group saw some of the earliest concrete bridges still existing in Oregon. On the way back south to Klamath Falls, a stop at the Crooked River crossing allowed for a comparison of early rail, vehicle and modern bridges. The final bridge on the tour was a recent McCullough bridge replacement project that made clear the value of Conde McCullough’s contribution and legacy.

In addition to the late-summer field component, the fall term included one class meeting per week to develop ideas that were related to the bridge tour including a history of computational, mechanical and graphical methods of structural analysis, a survey of other bridge engineers in the United States, and a comparison of the design philosophies of Conde McCullough and Swiss engineer Robert Maillart [5]. The richness of the resulting discussions and the range of topics
were unlike anything the instructors had experienced before and were certainly the result of the unique format and rich field component of the class.

The singular assignment for the course was a portfolio of the bridges that were visited including factual content about the bridges that included their condition ratings and structural assessments, but also a reflective component that requested that the students organize the bridges in some meaningful way beyond simply the order in which they were visited. The students also used the portfolio to reflect upon the trip and the legacy of Conde McCullough in Oregon.

The remainder of this paper will describe the assessment of the course from the instructor point of view. First, a number of challenges are presented when a field component is included in a course. We discuss these and some of the solutions we identified upon reflection on our experience. Second, we articulate some of the administrative hurdles involved in offering a field course. Third, we discuss co-teaching, which offered the opportunity to combine perspectives on bridge design in a unique way, but resulted in difficulties in scheduling and higher costs for course delivery. Fourth, we present assessment of student perceptions of the course as well as their learning as demonstrated by their portfolio submissions. All of this reflection has resulted in a significant re-design of the course schedule and conduct for the next planned offering of the course. Finally, we consider future work to evaluate the course within the context of the university’s general education requirements, ABET outcomes, and ASCE Body of Knowledge criteria, each of which informed the development of the courses, but was not assessed in a rigorous way.

**Course Challenges – Field Component**

Any new course presents challenges with respect to design and implementation, but this course was particularly difficult to implement due to the duration and structure of the field component. In our experience, the most notable issues were the selection of the bridges to be visited (and those that were skipped), the logistics and financial details of travel, and the maturity of the students involved. A related issue, which also extended to the classroom portion of the course, was the difficulty of coordinating co-teaching and accounting for faculty workload.

**Bridge Selection**

Selection of bridges to be visited presented a number of challenges. First, we wanted to present as broad a variety of bridges to the students as possible. Generally speaking, we wanted to include a broad range of bridge types (arch, truss, beam, etc.), bridge materials (wood, reinforced concrete, pre-stressed concrete, steel), decorative features (classical, art nouveau, modern, etc.), and dates of construction. In addition, we also wanted to include bridges that made a point about the particular nature of bridge design in Oregon. This meant taking into account coastal locations and the need to provide corrosion protection and access to ports, the impact of environmental regulations, the potential impact of a Cascadia subduction zone earthquake, and the need to visit examples of the work of different bridge designers, particularly the work of Conde McCullough.

The second challenge associated with bridge selection was a logistical one. Limitations of time and money dictated that we would not be able to visit every potential bridge on our route. Moreover, many of the bridges to be visited were widely separated in terms of distance,
requiring long travel times and planning for stops for meals, fuel, and restrooms. As a result, we were able to see far fewer bridges than we would have liked.

A third challenge was the question of safety. Many of the bridges we visited were built decades ago, and had minimal provisions for pedestrian access and limited parking. Moreover, we had to ensure access for students of all physical abilities. Altogether, this meant that several bridges that would have been prime candidates for inspection, including the oldest bridge still in regular use on the main route of Oregon’s coastal highway, proved unacceptable on the grounds of safety.

We dealt with these challenges with varying levels of success. By far the biggest surprise was that we were able to visit such a large number of bridges of such varying types in such a short period of time. We attribute this to two factors. First, we had been able to visit almost all of the bridges the year before offering the class during a scouting trip by both instructors. Funded by a grant from the Commission on College Teaching at our university, this trip followed nearly the same route as the actual field experience. Since we were not constrained by the need to manage the movement of multiple students on the scouting trip, we were able to visit a much larger number of bridges than we eventually used in the field experience. As a result, we were able to make an informed selection of the bridges we visited for the course. In particular, we were able to reject a number of seemingly important bridges on safety grounds, avoiding potential liability.

The second factor that contributed to our ability to visit a large number of bridges was the practical knowledge we gained from our scouting trip in terms of travel times, locations of potential lodging, food and fuel stops. As a result, we could evaluate travel plans from more than just maps and tourism guides. We highly recommend such a preliminary tour of a field course route – we believe it was the single most important contributor to the success of the field component of the course.

The limitations imposed by time constraints did have a small impact on the students’ exposure to a variety of bridge designs. The most notable omissions were that we did not see an example of a covered wooden bridge during our trip, and that we were unable to stop at the Umpqua River Bridge in Reedsport, the only example of a highway swing-span bridge on the Oregon coast. We had visited both of these during our tour the previous year, and were unable to include them due to time constraints. However, bridges like this were deemed “bonus bridges” by the students and were the subject of conversation and impromptu internet investigation while driving.

Considerations of safety also led to the omission of several bridges from our schedule, most notably the oldest bridge on the main coastal highway, a modest closed-spandrel reinforced concrete arch structure originally built in 1914 and widened in 1931. The lack of parking, sidewalks, and public access made it too dangerous to visit, despite its historical significance and unique design history. Again, the faculty tour the prior year allowed us to realistically evaluate the site and make an informed decision.

**Financial Issues**

We experienced challenges related to financial constraints imposed by university policy. Since the course was new and experimental, the university imposed a cap on the laboratory fees that could be collected from students to fund travel. This meant that we were limited in terms of the
accommodations we could afford and that students were required to pay for meals out of their own pockets.

Financial constraints due to the limitation on fees proved to be the most challenging aspect of logistical planning. We were unable to afford hotel rooms for the initial four-day portion of our trip along the Oregon Coast, and so elected to camp at state parks. While the facilities were adequate, the lack of nearby restaurants and the need to set up and pack tents meant that we had less time for travel and bridge visits. The lack of meeting facilities and internet access also meant that we could not conduct class-related activities in the evening, though bonding around evening campfires proved to be a positive benefit. We were also lucky when it came to weather. September on the Oregon coast is often rainy, and the fact that we only had one rainy night with very light rainfall was a blessing. We would likely not be so lucky in the future.

In contrast, during our time in the city of Portland, we were able to secure inexpensive accommodation at a motel downtown. Students had to sleep four to a room, but after their time camping they were happy to do so since they had warm, comfortable beds out of the rain. Accommodations clearly made a difference, as the students were more rested and better prepared for each day’s activities.

**Student Maturity**
Perhaps the most challenging aspect of the field experience was dealing with issues related to student maturity and interpersonal conflict. Perhaps naively, we had believed that the students were adults and would behave as such, particularly since almost all of them were over 21 years of age. As a result, we had not spent a great deal of time developing standards for student behavior or setting up a detailed schedule for activities outside of the itinerary of bridge visits. We had also made suggestions to the students as to the data they should be collecting during the field experience as a background for their course portfolios, but we did not check in with them during the trip to make sure they were writing in their journals and taking pictures at each bridge.

Unfortunately, the stress of spending multiple days together in small passenger vans and on site at bridges proved to be too much for many of the students, and their behavior suffered. There was conflict over what music to play as we drove, where to eat and at what price point, and who would ride with whom each day in the vans. By the end of the trip, it seemed that many of the students were sick of one another, and it was fortunate that some time elapsed before we went on to the classroom component of the course so that they could recover their equilibrium. It proved stressful for the faculty as well, as we had to step in to resolve the issues. Since neither of us is particularly dictatorial by nature, we sometimes waited too long to intervene, letting resentments fester. We clearly need to address this when we offer the course again in the future.

**Administrative Hurdles**
Any course operating so far outside of the traditional university classroom/laboratory structure is bound to have some administrative challenges and this certainly proved true. In some cases, we found alternative approaches, but offering this class proved much more challenging than our usual teaching duties.
Due to the small number of students (we limited enrollment due to the perceived logistical challenges of the field component), we had to obtain a workload waiver from our deans, a process complicated by the fact that we teach in two separate colleges. Fortunately, our department chairs were fully supportive, and we were able to list the class. However, we have been told that future offerings of the course must have a significantly larger student enrollment, which will present additional logistical challenges.

Another complication was setting a course fee that covered the cost of the field course. University rules require fees above a certain amount to be approved well in advance, and we were unable to meet that deadline due to a misunderstanding. The registrar’s office provided a work-around by listing the field experience separately from the classroom experience, allowing us to collect the maximum allowed fee from both class sections. However, the business office objected to this arrangement after the course was listed, complicating collection and distribution of funds. We have applied for a larger course fee for the next offering of the course, and anticipate that this will not be a problem.

Finally, the support of our administration for the class has been somewhat inconsistent. Although recent general education reforms in theory favor the development of courses like ours that blend the expertise of two or more faculty members, the implementation of that reform has been protracted and inconsistent. As a result, we spent a great deal of time trying to persuade our department chairs that the class was a good idea and then needed their support when dealing with other university departments.

Co-Teaching
Co-teaching proved to be by far the most rewarding part of the course from the instructors’ point of view, and was also cited by students as a valuable part of the course. We were able to learn much from one another, and the sum of the material covered was greater than the parts as both students and faculty were exposed to a rich and multi-faceted approach to the topic. In particular, the students, who were all civil engineering majors, were exposed to the social and cultural context of engineering practice in a very experiential way.

The downside of co-teaching was as you might expect – it took significantly more work, as everything had to be coordinated. The two instructors also vied for instructional time. This was not an issue during the field component, as there was plenty of face-to-face time with the students, but was more of an issue with the classroom portion of the class. We plan to expand the classroom sessions the next time the course is offered, and will also use more flipped-classroom practices, providing students with online videos to prepare them for classroom group activities.

Assessment of Course Components and Student Learning
After what seemed to be a profoundly different teaching experience than we had ever had, we were excited to have the students assess the course and we were also excited to assess their portfolios.

Seven of the eight students completed a survey that included qualitative questions as well as ranking of various aspects of the course on a sliding scale from 0 (low) to 100 (high). Based on a ranking by the students of the importance of the various course components, it was clear that the
field component of the course and the co-teaching model were highlights (Figure 3). The perceptions of the classroom component varied widely as would be expected in a class of diverse students. The perceptions of the portfolio were similar but were scored lower, likely due to the considerable workload of reflecting and researching meaningfully on nearly 50 different bridges. The student comments regarding the strengths of the courses tell a consistent story with all referencing the field component and some addressing co-teaching and the inclusion of professionals in the field (Table 1). The students rated the overall effectiveness of the course at 92% (82% low, 100% high).

![Figure 3. Results of student survey of the value of various course components (min, avg, max).](image)

The students suggested areas for improvement that revolved around the challenges of being on the road with a busy itinerary, but they also suggested ways to better align the field and classroom components, facilitate notetaking in the field, and use effective physical models at appropriate times (Table 2). Their thoughtfulness is incredibly valuable as we work to make improvements to future offerings.
Table 1. Student responses regarding strengths of the course.

<table>
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<tr>
<th>Please identify what else you consider to be the strengths of the course.</th>
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<tbody>
<tr>
<td>I think the strength of the course is the small class size. I think the amount of students in the class allowed for a more intimate learning experience. Students were able to have a more personal learning experience with the professors relative to a 50 minute lecture course, or 3 hour lab. This allowed students a more relaxed learning environment.</td>
</tr>
<tr>
<td>The strength of the course is the field portion. This gives students a chance to see how different bridge types were used for similar and different crossings. The strength comes from the close interaction with the teachers. This allowed the students to ask any question they had regarding the bridge in a relaxed setting, allowing the students to absorb the information in a new way, relative to it being presented in a Power Point with a limited amount of class time to ask questions.</td>
</tr>
<tr>
<td>The resources as far as people that we met that allowed us to see more of the bridge than we could have without them. I also think the small amount of students helped the learning process.</td>
</tr>
<tr>
<td>Seeing and talking to professionals who are working in the field. This is isn't common in most classes and made the course exceptional.</td>
</tr>
<tr>
<td>Getting to road trip up Hwy 101 with classmates and knowledgeable professors during beautiful weather was an experience I will not forget. I have a much greater appreciation for the history of Oregon bridges that really can't be conveyed in a typical classroom setting. In that sense, the idea of the class REALLY works.</td>
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</table>

Table 2. Student responses regarding areas for improvement.

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<th>Please identify area(s) where you think the course could be improved.</th>
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<tr>
<td>I think the class could improve with more technical learning in the field. The professor used a model of an arch in the classroom portion to demonstrate the concept of horizontal thrust, and I think this type of demonstration in the field would help students get a better visualization of the behavior of an arch.</td>
</tr>
<tr>
<td>I think the course could improve by incorporating more of the classroom lessons we got during the term into the field portion. I think there should be one day, where one bridge is analyzed from the engineering aspect and the history aspect. I also think that a study guide with lines to write notes for each bridge would help students take more notes of each bridge.</td>
</tr>
<tr>
<td>Shorter days, and if at all possible making it cheaper.</td>
</tr>
<tr>
<td>I believe the course work should have been more explained. I understand this is the first time doing it and there wouldn't have been an example for the portfolio. This made figuring out what was expected difficult.</td>
</tr>
<tr>
<td>The selection of bridges we visited, which was well thought out and efficient, could use a little refinement. Some of the bridges deserved more time that we could afford and some deserved a less than we spent.</td>
</tr>
<tr>
<td>I think the schedule could be improved a bit. We tended to spend more time at bridges than we planned, and by the end of the day everyone was so tired and hungry that they weren't interested anymore. I also think it would be helpful to limit the class to students who have at least taken structural analysis so everyone is sort of on the same page when we talk about how a bridge was designed at what that means.</td>
</tr>
</tbody>
</table>

The portfolios produced by the students ranged from satisfactory to truly impressive. By request, they included a catalog of the bridges arranged in a meaningful way (age, structure type, etc) that was not the order in which we visited them. They included sufficiency and condition ratings of
each structure as well as location and photographs. Students were tasked with researching each of the 45 bridges we visited and adding a description of the structure type as well as explanations of the social, economic, and technical importance of the structure. In some cases, these explanations were very perceptive, identifying details unknown even to the faculty prior to the trip. A piece of trivia regarding the 1914 braced-spayndrel reinforced concrete deck arch at Latourell Creek on the historic Columbia River highway is indicative of the level of research and fact finding that the trip motivated in the students: “It is estimated that the bridge required only 560 cubic yards of concrete to construct, and was thought to be the lightest concrete bridge in the country, if not the world (Dolan 1915).” Even if the superlative identified in this statement is in question, the consideration of what a light concrete structure would be is a richer and more valuable exercise than most students see in an undergraduate civil engineering curriculum.

In addition to evaluating the portfolios, we surveyed students to measure their perceived learning according to the course objectives (Figure 4). Each student was asked about the common course objective (n=7) and the course objectives specific to the section in which they were enrolled (history n=3, civil engineering n=4).

![Figure 4. Student self-reported perceptions of achievement in course outcomes (min, avg, max).](image-url)
The outcomes of the history section were very well supported by the trip and classroom discussion, while the more technical outcomes of the civil engineering section were less certain. Analysis of an existing bridge was supported by reviewing Conde McCullough’s text *Elastic Arch Bridges* [2] and design calculations for the Caveman Bridge in Grants Pass and attempting a numerical model of the structure. It seems clear from the zero score that one student did not deem this a sufficient analysis. The discussion of lifeline routes and seismic hazards was emphasized on the trip as we traversed tsunami hazard zones and in a classroom session summarizing Oregon DOT reports and plans, however these results indicate that more careful treatment of this content and targeted assignments should be included in future offerings.

**Comparison with Traditional Courses**
The unique subject matter and structure of the Oregon Bridges course make comparisons with other courses in our university’s curriculum difficult. On the civil engineering side, there are design courses that address bridge design as part of the curriculum, but there is no comparable coverage of bridge maintenance and the need for seismic and corrosion upgrades. Exposure to these topics ensured that students had a much broader understanding of the issues that bridge designers and asset managers deal with. On the history side, the only course with similar content is a junior-level class on the history of the engineering profession, which includes a week-long unit on C.B. McCullough and his bridge designs [1]. In comparison, our course allowed a much more in-depth treatment of McCullough’s bridge design work. The personal experience the students had with McCullough’s bridges meant that there was a noticeable increase in the depth and sophistication of the students’ understanding, as demonstrated both in their classroom discussion and in their written work.

**Future Work: Connecting to the ASCE Body of Knowledge and ABET Outcomes a-k**
Teaching an engineering course based on physical interaction with historical and modern civil infrastructure addresses the goals of engineering education in a particularly comprehensive way. Examining ASCE’s Body of Knowledge and ABET’s learning outcomes, it becomes very apparent that exposure to engineered works in the field with some additional classroom activities is a good way to draw together the breadth of the outcomes our students are expected to demonstrate. In future offerings of the course, we anticipate a more rigorous assessment of these outcomes. The ABET outcomes a-k are listed here with an evaluation in italics of their potential for evaluation given the conduct of this first offering of the course.

- A. Yes. an ability to apply knowledge of mathematics, science, and engineering
- B. Possible. an ability to design and conduct experiments, as well as to analyze and interpret data
- C. Not necessarily. an ability to design a system, component, or process to meet desired needs
- D. Maybe. an ability to function on multi-disciplinary teams
- E. Yes. an ability to identify, formulate, and solve engineering problems
- F. Yes. an understanding of professional and ethical responsibility as well as the importance of professional licensure
- G. Yes. an ability to communicate effectively
- H. Yes. the broad education necessary to understand the impact of engineering solutions in a global and societal context
- I. Yes. a recognition of the need for, and an ability to engage in life-long learning
- J. Yes. a knowledge of contemporary issues
- K. Maybe. an ability to use the techniques, skill, and modern engineering tools necessary for engineering practice

Similarly, many of the criteria in ASCE’s Body of Knowledge were addressed in this course. We propose that a field course is one of the more effective ways of comprehensively addressing multiple outcomes in the BOK. Others have focused on case studies as an effective means of connecting to historical and social context. This course is unique as we have used the field component and Conde McCullough as a whole-course case study of a model civil engineer and his exceptional works. Among those outcomes best supported by such a course are

4 – Demonstrate the incorporation of social sciences knowledge into the professional practice of engineering
5 – Materials science
6 – Mechanics
9 – Design
10 – Sustainability
11 – Contemporary issues and historical perspectives
12 – Risk and uncertainty
17 – Public policy
18 – Business and public administration
20 – Leadership
21 – Teamwork
22 – Attitudes
23 – Lifelong learning
24 – Professional and ethical responsibility

Relatedly, the Oregon Tech General Education Review Task Force has recently proposed a new general education model for the university, termed Essential Studies (reference to be added after review), to support student success in the six Essential Student Learning Outcomes (ESLOs):

- Communication (Written and Oral)
- Inquiry and Analysis (in Humanities, Social Sciences, and Natural Sciences)
- Ethical Reasoning
- Teamwork
- Quantitative Literacy
- Diverse Perspectives

As we reflected on this experience, it was clear to us that this course could easily support the Essential Studies Synthesis Experience (ESSE), a proposed junior-level interdisciplinary course that draws together the skills and habits of mind developed in the foundation coursework supporting the ESLOs. Emphasizing teamwork and using effective teaming is the only significant change necessary to satisfy the requirements of the ESSE.
Future Work: Re-Design of Field Experience Component

Based on our experience with the course, we have decided that we are eager to offer it again, but we do want to make a number of changes before the next time we do.

First, the course will be moved from the Fall term to the Spring term, and the field component will take place during the term rather than separately. We feel this will have a number of advantages. First, we will have a chance to work with and get to know the students before the field course. Second, the students will have more background knowledge about Oregon’s bridges before they go on the field trip. Third, faculty will be able to devote the summer to developing other courses and carrying out research.

There are a number of potential drawbacks to this change. The weather in May is likely to be worse, but should be manageable since there will be no camping. Students will miss class days in other courses, but given that many already do so due to athletics and other activities, other instructors will likely be able to accommodate this. We think the tradeoffs are worth the change.

Second, the number of classroom instruction hours will be increased from one per week to two per week. This will make co-teaching easier, since there will not be as much time pressure. It will also allow topics to be covered in more depth.

Finally, the field component will be reduced to eight days and will be divided into two separate trips. This will balance the change in classroom hours. The first trip will be to the southern Oregon coast, and the second will be to the Portland area. Both trips will be four days, Thursday through Sunday, and will be conducted by van in much the same fashion as the initial course offering. All overnight stays will be in motels. An analysis of the itinerary shows that we will be able to visit approximately 90% of the bridges previously visited, and we will be able to add a covered wooden bridge, as we will be taking a different route to Portland where one is easily accessible.

Conclusions

Standing next to a real structure and discussing the methods of its creation in its time and place as well as concepts in fundamental mechanics and design of steel or concrete provide for a profound learning experience. Having access to experts in these areas via a co-teaching method affords students multiple perspectives on a particular structure and on civil engineering broadly. And while a field experience can be simulated in the classroom or laboratory, when it comes to civil engineering and history, there is simply nothing like being there. The experience described above shows that the value of such a rich learning experience far outweigh the challenges overcome to provide it.

Acknowledgements

The authors would like to acknowledge the funding and support of the Commission on College Teaching at Oregon Institute of Technology for supporting the scouting trip that made the first offering of this course so successful. We would also like to thank the many Oregon DOT staff who contributed time and expertise to meet with our students and further enrich the tour.
References


Appendix – Detailed Itinerary

Day 1, Monday, September 5 – Southern Oregon Coast – Klamath Falls to Brookings

08:00   Meet at Cornett North parking lot to pack vans (tents, hardhats, vests)

08:30   Depart Klamath Falls

10:15  Arrive at Rock Point Bridge (McCullough 1920), Gold Hill, I-5 exit 43
One of McCullough’s first reinforced concrete bridges in Oregon
http://bridgehunter.com/or/jackson/33227100009/
http://loc.gov/pictures/item/or0296/

Travel to Gold Hill Bridge (McCullough 1927), Gold Hill
The only barrel-type arch in the state…why this design?
http://bridgehunter.com/or/jackson/576271Y00265/
http://loc.gov/pictures/item/or0304/

11:00 Arrive Grants Pass; Lunch

12:00 Caveman Bridge (McCullough 1927), Grants Pass
https://bridgehunter.com/or/josephine/caveman/
http://loc.gov/pictures/item/or0278/

12:45 Tussing Park Stressed Ribbon Bridge (Strasky/OBEC 2000)
http://www.kniferiverprestress.com/pdfs/GapedBridge.pdf
http://www.vegvesen.no/_attachment/397763/binary/683427
http://cenews.com/article/7918/dramatic-bridge-provides-a-natural-crossing

13:30  Depart Grants Pass

15:30  Arrive Chetco River Bridge (Wilson 1972), Brookings
Allen p. 151
Prestressed Concrete Institute (PCI) Award Winner
http://uglybridges.com/1447934
Note that other National Bridge Inventory data is linked from bridgehunter.com pages for
future bridges. See details on reading NBI reports from uglybridges.com below.

16:00 Depart Brookings

16:30 Arrive Thomas Creek Bridge (Merchant 1961)
Allen p. 147
Continuous Warren truss, highest bridge in Oregon
https://bridgehunter.com/or/curry/845900934778/

17:15 Depart Thomas Creek Bridge and go back to Brookings
17:45 Arrive Brookings; Dinner; Camp at Harris Beach State Park Sites C21 and C23
Day 2, Tuesday, September 6 – Brookings to Coos Bay

09:00  Depart Brookings

9:30  Arrive Rogue River Bridge (McCullough 1931)
  Allen p. 139
  One of McCullough’s “jeweled clasps”
  https://bridgehunter.com/or/curry/patterson/
  http://loc.gov/pictures/item/or0305/

11:00  Depart Gold Beach

11:15  Arrive Euchre Creek Bridges
  Ophir Road (McCullough 1927)
  Hwy 101 (ODOT 2009)
  Allen p. 135 and 137
  Modern materials and proportioning vs. classic McCullough
  https://bridgehunter.com/or/curry/euchre-creek/

12:30  Picnic lunch

13:00  Depart Euchre Creek

13:15  Arrive Brush Creek Bridge
  Allen p. 131
  McCullough’s arch legacy with a 120 year design life thanks to stainless steel reinforcing
  https://bridgehunter.com/or/curry/1809600930635/

Regarding the embellishments on the Brush Creek Bridge, Abigail Glanville’s statement about McCullough’s decorations provides some guidance:
“An artistic rhythm is reflected in the decorative pylons, railings, and spires he designed that allows one the ability to read the beginning and end of his spans, as well as points of major support in the substructure below.”

14:45  Depart Brush Creek Bridge

17:30  Arrive Coos Bay; Dinner

19:00  Camp at Sunset Beach State Park sites C23 and C25
Day 3, Wednesday, September 7 – Coos Bay to Newport

09:00  Coos Bay Bridge/McCullough Memorial Bridge
       (McCullough 1936)
       Allen p. 117
       Meet Mike Goff, Oregon Tech Class of ‘08
       and ODOT Region 2 Bridge Inspector
       http://bridgehunter.com/or/coos/mccullough/
       http://loc.gov/pictures/item/or0312/
       Note as we travel north, the Haynes Inlet Slough Bridge (Bollman 2001) and the visual
       continuity it creates with the McCullough Memorial Bridge, like you’ve skipped a stone through the
       peninsula
       Allen p. 115

10:00  Depart Coos Bay
       Note as we travel north, the Umpqua River Bridge at Reedsport (McCullough 1936), one of
       the big five and the only swing span on the coast
       Allen p. 109

       Note as we drive through ___ State Park,
       the precast panel façade on the pedestrian bridge. Does stone actually work this way?
       Google StreetView

11:00  Arrive Florence; Siuslaw Bridge (McCullough 1936)
       Allen p. 101
       (Gothic and ornate – it’s no wonder the folks in Florence love it)
       Meet with Nate Neal to tour cathodic protection work
       http://bridgehunter.com/or/lane/1821e00919098/
       http://loc.gov/pictures/item/or0287/

12:30  Lunch

13:00  Depart Florence

13:15  Arrive Cape Creek Bridge (McCullough 1931)
       Allen p. 95
       (It might as well be a Roman aqueduct)
       http://bridgehunter.com/or/lane/cape-creek/
       http://loc.gov/pictures/item/or0308/

15:15  Depart Cape Creek Bridge
15:45  Arrive Waldport; tour Alsea Bay Bridge Interpretive Center
       (open 9-5 every day of the week)

17:00  Alsea Bay Bridge (HNTB 1991)
       p. 75
       (Did they do a good job replacing one of McCullough’s nicest bridges?)
       http://bridgehunter.com/or/lincoln/1746B00915554/
       http://loc.gov/pictures/item/or0345/

17:30  Dinner

19:00  Camp at Beverly Beach State Park sites A33 and A32
       Spencer Creek Bridge (ODOT 2008)
       Allen p. 61
       (Why did they glue that tacky fake stone on such a nice bridge?!?!)
Day 4, Thursday, September 8 – Newport Area to Portland

09:00 Yaquina Bay Bridge, Newport (McCullough 1936)
   Allen p. 65
   (McCullough’s biggest – maybe his best?)
   Meet at north abutment with Andrew Blower
   ODOT Corrosion Protection Engineer
   http://bridgehunter.com/or/lincoln/yaquina-bay/
   http://loc.gov/pictures/item/or0310/

11:00 Depart Newport

11:20 Arrive Rocky Creek (Ben F. Jones) Bridge (McCullough 1927)
   Allen p. 57
   (A lovely bridge in a lovely setting; the benefits of bypass)
   http://bridgehunter.com/or/lincoln/1089009F13003/
   http://loc.gov/pictures/item/or0482/

12:00 Depart Rocky Creek Bridge

12:20 Arrive Depoe Bay; Lunch

12:45 Arrive Depoe Bay Bridge, Depoe Bay (McCullough 1927/1940)
   Allen p. 53
   (Widening a bridge is not easy)
   http://bridgehunter.com/or/lincoln/245900912761/
   http://loc.gov/pictures/item/or0303/

13:30 Depart Depoe Bay

13:30 West Beaver Creek Bridge (1914/1935)
   WARNING DANGEROUS BRIDGE
   Allen p. 43
   (Built in 1914, still going strong)
   http://bridgehunter.com/or/tillamook/220200907753/

14:30 Depart West Beaver Creek Bridge

15:00 Wilson River Bridge, Tillamook (McCullough 1931)
   Allen p. 39
   (We skipped earlier tied arches – can’t skip them all)
   http://bridgehunter.com/or/tillamook/149900906423/
   http://loc.gov/pictures/item/or0306/

15:45 Depart Tillamook

17:30 Arrive Portland; Dinner on your own; Lodging at University Place Hotel
Day 5, Friday, September 9 – Portland, National Institute for Transportation and Communities, Transportation and Communities Summit

http://trec.pdx.edu/summit/2016

Please dress business casual. Plan to distribute students to each of the breakout sessions and debrief on the contents during dinner.

07:30 Meet in hotel lobby to walk to PSU; breakfast at hotel optional
07:40 Arrive PSU; Registration and Breakfast (may not be as complete as hotel breakfast)
08:15 Welcome
09:00 Breakout Session 1
   Room 238: Getting Ahead of the Autonomous Future
   Room 296/8: Putting Equity into Multimodal Transportation Planning
   Room 294: Planning for Emergencies and Recovery
10:30 Break and Poster Session
11:00 Breakout Session 2
   Room 294: Travel Choices of Tomorrow
   Room 238: Mitigating Displacement from Transportation Investments
   Room 296/8: Economic Impacts of Transportation Projects
12:30 Lunch and Keynote Address by Brian David Johnson, Futurist
14:00 Break and Poster Session
14:30 Breakout Session 3
   Room 296/8: Performance Measures for Livable Communities
   Room 238: Achieving Vision Zero
   Room 294: Redesigning Suburbia
16:00 Closing Reception
18:00 Summit concludes. Dinner together to discuss session topics; location TBD.
Day 6, Saturday, September 10 – Astoria to Portland North

08:00 Depart University Place Hotel

10:00 Old Young’s Bay Bridge (McCullough 1921)
   Allen p. 17
   (A coastal bridge made of wood? Really?)
   http://bridgehunter.com/or/clatsop/33010500689/
   http://loc.gov/pictures/item/or0507/

11:00 Depart Bridge

11:30 Arrive Columbia River Bridge (Merchant 1966)
   Allen p. 5
   (It's big, that's for sure)
   https://bridgehunter.com/or/clatsop/astoria/
   http://loc.gov/pictures/item/or0276/

12:30 Lunch in Astoria

13:30 Depart Astoria

14:30 Arrive Lewis and Clark Bridge (Joseph Strauss 1930)
   https://bridgehunter.com/wa/cowlitz/longview/
   http://loc.gov/pictures/item/wa0430/

15:40 Arrive Sauvie Island Bridge (David Evans and Associates 2009)
   Wortman Walking Bridges Exploration 4 p.93
   http://bridgehunter.com/or/multnomah/sauvie-island/

16:00 Arrive St. Johns Bridge (Steinman 1931)
   Gothic inspiration for McCullough?
   http://bridgehunter.com/or/multnomah/st-johns/
   http://loc.gov/pictures/item/or0307/

16:30 Depart St. Johns Bridge

16:40 Arrive Fremont Bridge (Parsons Brinckerhoff 1973)
   Navigate to 1750 NW Naito Pkwy
   https://bridgehunter.com/or/multnomah/fremont/
   http://loc.gov/pictures/item/or0473/
   Wortman Walking Bridges p.96

17:00 Depart Fremont Bridge

17:10 Arrive at University Place Hotel;
   Dinner on your own
Day 7, Sunday, September 11 – Portland South (aka A Modern McCullough Sandwich)

09:30 Depart Hotel
09:45 Arrive Sellwood Bridge (T.Y. Lin International 2016)
   http://www.sellwoodbridge.org/
   http://bridgehunter.com/or/multnomah/tacoma-street/
   Park on southeast side

10:15 Depart Sellwood Bridge

10:45 Arrive Dr. John McLoughlin Memorial Bridge (McCullough 1933)
   Park on southwest side in the Clackamette Park
   1933 American Institute of Steel Construction Award Winner
   http://bridgehunter.com/or/clackamas/161701E01120/

11:15 Depart McLoughlin Memorial Bridge

11:30 Arrive Oregon City Bridge and Municipal Elevator (Railroad Ave and 7th)
   Lunch
   Oregon City Bridge (McCullough 1922)
   http://bridgehunter.com/or/clackamas/35700301143/
   http://loc.gov/pictures/item/or0298/
   Ride the (free) Municipal Elevator for a view:
   http://www.orcity.org/publicworks/municipal-elevator

13:00 Depart Oregon City

14:00 Return to University Place, park vehicles
   Street car, Orange Line, or walk to South Waterfront
   Portland Aerial Tram (http://www.gobytram.com/)
   to Veteran’s Administration Medical Center Skybridge
   (longest air-conditioned pedestrian bridge in the US)
   Roundtrip fare: $4.55
   Wortman Walking Bridges p.83

15:30 Ross Island Bridge (Lindenthal 1926)
   http://bridgehunter.com/or/multnomah/ross-island/
   http://loc.gov/pictures/item/or0471/

15:00 Tillikum Crossing (HNTB 2016)
   http://bridgehunter.com/or/multnomah/bh56420/

16:00 Arrive at University Place Hotel; Dinner on your own

21:00 Optional: Meet in lobby for Portland bridges by night
Day 8, Monday, September 12 – Portland Central (aka Moveable Monday)

07:00 Optional morning run: North to Steel Bridge, cross, south to Hawthorne Bridge, return (~3 miles)

08:00 Breakfast at University Place

09:00 Depart from lobby with helmets to Portland Bike Share locations to pick up bikes
https://www.biketownpdx.com/, $12/day
Note: it is 1/3 mile between bridges and 2.1 miles from University Place to the Broadway Bridge on the west side.

09:30 Arrive at ODOT Region 1 offices and museum
123 NW Flanders St.
Wortman Walking Bridges p.45

10:30 Arrive at Broadway Bridge (Modjeski 1912)
http://bridgehunter.com/or/multnomah/675700000000000/
http://loc.gov/pictures/item/or0292/

10:00 Steel Bridge (Waddell and Harrington 1912)
http://bridgehunter.com/or/multnomah/steel/
http://loc.gov/pictures/item/or0291/

12:00 Lunch

13:00 Burnside Bridge (Lindenthal and Strauss 1926)
http://bridgehunter.com/or/multnomah/5110000000000/
http://loc.gov/pictures/item/or0470/

13:30 Morrison Bridge (Sverdrup and Parcel 1958)
http://bridgehunter.com/or/multnomah/morrison-street/
http://loc.gov/pictures/item/or0469/
Look for all other bridges from north side viewpoint
Wortman Walking Bridges p.50

14:00 Eastbank Esplanade (Hargreaves Associates 2001)
Longest floating walkway in the US
Portland Parks and Recreation Site

14:30 Hawthorne Bridge (Waddell and Harrington 1910)
http://bridgehunter.com/or/multnomah/hawthorne-avenue/
http://loc.gov/pictures/item/or0290/

15:30 Arrive at University Place Hotel; Dinner on your own
Day 9, Tuesday, September 13 – Portland to Klamath Falls

08:00  Depart Portland

09:00  Vista House, Historic Columbia River Highway

10:00  Bridge of the Gods (1926) and Cascade Locks
       http://bridgehunter.com/or/hood-river/bh36607/

10:30  Hood River Bridge (Wing 1924)
       http://bridgehunter.com/or/hood-river/6645002C06462/

12:30  Madras; Lunch

13:30  Crooked River Bridges

Rail Bridge (Modjeski 1911)
       http://bridgehunter.com/or/jefferson/crooked-river-rail/
       http://loc.gov/pictures/item/or0277/

Original Hwy 97 (McCullough 1926)
       http://bridgehunter.com/or/jefferson/crooked-river/
       http://loc.gov/pictures/item/or0302/

Rex T. Barber Bridge (T.Y. Lin 2000)
       https://bridgehunter.com/or/jefferson/1821100411264/

14:30  Depart Crooked River Bridges

17:00  Romeo and Juliet Bridge, Collier State Park

Original (McCullough 1948)
       http://bridgehunter.com/or/klamath/old-spring-creek/

Replacement (Hart/ODOT 2005)
       http://bridgehunter.com/or/klamath/spring-creek/

18:00  Depart Collier State Park
18:45  Arrive Klamath Falls