

# Precast Bridge Studio Advances Academia-Industry Connections

## Preparing the Next Generation of Bridge Professionals

by Dr. Eric Matsumoto, California State University, Sacramento

What does innovation in the bridge industry look like? In the 2000s, when state departments of transportation began to implement self-propelled modular transporters for accelerated bridge construction to move bridges into place in mere hours, industry members and the public alike were stunned. People have similarly been surprised by recent advances in ultra-high-performance concrete, as new possibilities for bridge components and connections have emerged worldwide. Now, similarly bold innovations are needed in education to produce the next generation of bridge engineers as a tidal wave of baby boomers transitions into retirement.

In a Professor's Perspective in the Fall 2019 issue of *ASPIRE*<sup>®</sup>, I reported the initial results of a fresh approach—based on an academia-industry partnership—to prepare a new generation of bridge

engineers, construction managers, and others for the transportation sector. In this article, I highlight advances and lessons learned during the past four years of the PCI Foundation–sponsored Precast Bridge Studio (PBS) at California State University, Sacramento, and call for the bridge industry to develop more partnerships with academia for the sake of the next generation.

### PBS Objective and Synergy with Industry

The primary objective of PBS is to prepare a new generation of civil engineering (CE) and construction management (CM) bridge professionals through a challenging and innovative CE/CM “immersion” course project that requires student teams, under the mentorship of bridge industry members, to design a multispan precast concrete bridge and perform preconstruction services using actual bridge projects.

By developing close relationships between academia and industry, PBS has generated synergy not only among faculty, students, and a dedicated team of up to 20 bridge design and construction mentors but also among those who contribute to the immersion experience—precast concrete producers, bridge designers, fabricators, construction managers, contractors, suppliers, truckers, and others.

### Advancements in Course Content

To reach the PBS goal, studio course content extends significantly beyond a typical prestressed concrete design class. Although the studio leverages important resources such as the *AASHTO LRFD Bridge Design Specifications*, the *PCI Bridge Design Manual*, PCI eLearning modules, and California Department of Transportation bridge references,

An engineering mentor leads a project introduction workshop. Photo: Eric Matsumoto.

A precaster's chief engineer explains prestressed concrete girder details to students during a tour of a precast concrete plant. Photo: Eric Matsumoto.





An assistant civil engineering mentor guides a student team during a workshop. Assistant mentors provide relatable experiences and fresh ideas. Photo: Eric Matsumoto.



Dr. Matsumoto, California State University, Sacramento, visits the student team at San Diego State University to mentor the students participating in a Precast Bridge Studio hybrid online course. Photo: Eric Matsumoto.

it also uses a wide range of additional resources, many of which were conceived and prepared through academia-industry collaboration. These resources support ambitious team deliverables. For CE students, the deliverables include type selection reports, precast concrete girder selection, superstructure design using professional software with the results then checked by hand calculations, and professional design drawings. Meanwhile, CM students tackle site logistics, project schedules, and cost estimates that integrate project specifications with local jurisdictions.

Unique PBS resources include specially designed workshops, lectures, and field trips with an emphasis on direct industry interaction and hands-on experiences. Offerings include a project introduction workshop (bridge project description, bridge layout, member proportioning, and girder-selection exercises guided by mentors); bridge design software training; a precast concrete plant tour; a prestressing strand plant tour; a precast concrete girder erection field trip; and a cast-in-place versus precast concrete bridge construction workshop. Resources also cover bridge construction materials, seismic precast concrete connections and research, estimating and specifications, and bridge foundations. These essential technical resources equip students and instill them with confidence as they prepare team deliverables and present those deliverables before a panel of industry and faculty judges and a large audience at the PBS finale.

Industry mentors who guide the teams through the projects serve a critical function in advancing course content

with faculty. The most important lesson we have learned in developing course content has been to carefully consider industry recommendations, as these have led to key modifications such as the use of actual bridge projects from mentor firms, type selection reports, spreadsheet development for checking design software results, and joint CE/CM exercises in the interpretation of bridge drawings and identification of bridge components. Industry input also informed our decision to reduce course content so that teams can focus more on quality of deliverables.

### Student Teams and Industry Mentors

Through five years of PBS, student teams and industry mentorship have changed to meet the needs of the program. In year 1, teams consisted solely of CE students (five per team). Combined CE/CM student teams were formed in years 2 to 5, typically with four CE and two CM students per team. This arrangement seems to be ideal for participation and CE/CM student interaction.

CE/CM interaction was established as a major program goal, yet such interaction had never occurred in the college's history before PBS. This interaction has been formative for students, improving communication and collaboration between disciplines.

Mentors play an indispensable role by helping teams accomplish technical objectives and learn professional practice. Most PBS students are graduating seniors and invariably "mature" into promising future industry professionals through the intense immersion experience under the guidance and supervision of industry

mentors. Students quickly realize that mentors are rich resources of knowledge and experience but will not "hold students' hands." They expect students to do the work, come prepared, interact professionally, and produce quality deliverables on time.

Even in the bustling bridge industry within the Sacramento region, recruiting suitable mentors is a formidable challenge. However, recruitment has become easier over time as mentors have recognized the win-win opportunity that PBS provides: while helping students, mentors personally shape the future of the industry, influence the course content and the next generation, and observe first-hand the performance of prospective employees. Indeed, many students have been hired immediately upon (or before!) graduation. These new graduates bring their PBS experience to industry, and—in the words of Jim Voss, president of JVI and founder of the PCI Foundation—they "give precast a seat at the table."

Mentoring within the PBS paradigm requires considerable time and dedication. Encouragingly, the number of mentors has increased every year, from a single CE mentor per team in year 1 to an average of 2.6 CE mentors per team in year 5. This growth is a testament to the value the industry finds in this partnership and a recognition that each team needs multiple mentors.

The PBS has also carefully recruited assistant mentors, especially among program graduates. These younger mentors have shown great interest in serving, and they provide extraordinary value. They augment the work of



San Diego State University students get a close-up view of California wide-flange girder erection on Interstate 10 in Ontario, Calif. Photo: Con-Fab California.



Students get hands-on experience during a precast concrete plant tour. Photo: Eric Matsumoto.

senior mentors, provide increased and more relatable experience for students, propose fresh ideas, and help prepare new content. At the same time, they are trained under senior mentors to be part of the next generation. Assistant mentors have grown to represent over 40% of mentors during the past three years, with recent PBS graduates initiating requests to join their peers as assistant mentors.

The number of CM mentors has also grown, which is an important PBS goal. In the first four years, CE/CM teams had access to a small group of CM mentors with sufficient combined expertise to guide them. By year 5, an important objective was reached: two CM industry mentors were assigned to each team. This clearly facilitated CM student immersion, strengthened accountability, improved deliverables, and positively affected CE/CM student interaction.

### Statewide Expansion

During the past three years, PBS encountered what might be called “COVID serendipity”: an unexpected benefit from the pandemic. In fall 2020, PBS was conducted entirely online, as were most courses worldwide, and it became immediately apparent that course delivery was not bound by geography. This change in circumstances generated new PBS experiences and an opportunity to rethink possibilities for course delivery and collaboration. During spring 2022, I pioneered development of PBS as a hybrid online class to expand course access to students within other parts of California State University, the largest university system in the United States. In fall 2022, with strong encouragement from industry and

support from the PCI West executive director, I introduced a new hybrid online PBS course with five CE students joining remotely from San Diego State University (SDSU) and California State University, Los Angeles (CSULA).

While this expansion meant that Southern California students would join a Northern California class online for lectures, all students needed a genuine PBS “industry-immersion” experience. We took four main steps to ensure an immersive experience:

- The four SDSU students were grouped into one team with two Sacramento State CM students and guided by mentors remotely. During the pandemic, online mentoring was found to be quite effective and became the preferred method by industry mentors; therefore, in fall 2022, all teams were primarily mentored remotely. In addition, I visited SDSU to assess each student’s progress and bolster student learning through a small group session. The CSULA student, who was a more mature graduate student, was able to learn more independently and served as leader for another team.
- We mobilized the bridge industry in Southern California for student immersion. With the aid of PCI West, a local precast concrete producer welcomed the five of the students for a plant tour, and a Northern California precaster flew to Southern California to lead students on a California wide-flange girder erection field trip at Interstate 10 in Ontario, Calif.
- At semester’s end, with PCI West support, SDSU students flew to Sacramento State to present in person with their CM teammates at

the PBS finale.

- Finally, collaboration with the SDSU and CSULA professors laid a foundation for future development of this hybrid online approach, which promises to benefit the industry in California and beyond.

The effectiveness and long-term impact of PBS expansion statewide have yet to be fully determined. However, the SDSU team performed well, with team members unanimously reporting that the PBS class with its industry-immersion experiences and PBS finale solidified their interest in the precast concrete bridge industry. All SDSU team members were scheduled to attend the 2023 PCI Convention.

### A Call to Action

Thanks to the vision, guidance, and support of the PCI Foundation as well as local and regional industry commitment over the past five years, PBS at Sacramento State has innovated in education, advanced new connections between industry and academia, and produced new graduates who are well equipped to become the promising next generation that the precast concrete bridge industry urgently needs. With this progress in view, I challenge the bridge industry to take definitive steps to partner with academia and secure a new generation of engineers, construction managers, and others who can serve the transportation sector throughout the United States. **A**

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