# Using Live Projects in the Classroom

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**Abstract**

Several years ago, we developed a paper for the ASCUE conference about using live projects in the classroom. The Purdue Polytechnic and our department Computer and Information Technology (CIT) have always encouraged the use of team projects throughout our curriculum. As mentioned in the original paper as instructors we are always trying to improve the classroom experience, making it more interesting and meaningful to the student. Typically, the team project used is from the textbook or a project the instructor has worked on in industry and has modified to fit in the context of the class. We have a junior/senior level course CNIT 390 Supervised Practicum designed to combine university study with work experience. We used this course in 2013 and again last fall to give students a chance to work on a live project. The original project in 2013 was for a company that wanted a potential application and planned to view the results before deciding if they wanted to switch or maintain the current system. In 2017, the city of Columbus approached Purdue about developing a new smartphone app that monitored increased train traffic that was disrupting traffic on a main thoroughfare for the EMT, police and general public. They wanted a system developed to go live as soon as possible. In this paper, we will discuss the differences in the two projects and how that affected our efforts, results along with lessons learned from the two efforts.

**Introduction**

Purdue University has gone through many changes in the past few years, one of which directly affects the learning experience of our students. The development of the Purdue Polytechnic Institute, which Computer and Information Technology is part of, has led to increased emphasis on project based learning and, in particular, on working with industry partners. In the last several years, we have delivered one of our courses, CNIT 390 Supervised Practicum, an existing class that is used for that purpose. This paper will review how the class was organized and delivered and the results of the student developed projects. Finally, since the results of the projects are very different, we will review what we have learned from this experience and what it means in future endeavors involving "live" projects.

**Purdue Polytechnic**

Purdue University and the Purdue Polytechnic have seen many changes over the last five years. Many of these changes have involved how students should be prepared for jobs when they graduate from Purdue. Purdue President Mitch Daniels introduced a plan named Purdue Moves, with an agenda focused on areas including affordability and accessibility, world-changing research, STEM leadership and transformative education. The goal was to place Purdue as an elite academic institution not only nationally but also worldwide. Purdue Polytechnic Institute is part of the Purdue Moves under STEM leadership and the centerpiece for transforming the technology component. The Purdue Polytechnic Institute (PPI), previously the College of Technology, is one of 10 colleges at Purdue University offering undergraduate and graduate degrees including Computer and Information Technology (CIT). PPI is aimed at transforming the college through renewed undergraduate programs, a state of the art approach to how learning occurs, applied research, and a renewed focus on workforce development.

Among the more important points, PPI values student autonomy with their learning and believes that learning is a personal act of discovery with faculty playing the role of supporting rather than driving the students' learning. PPI also values open-ended inquiries that have inherit risks and are one of the keys to learning and creativity. The PPI values intrinsically motivated students and the just in time approach (learning when needed to solve a problem) as opposed to just in case (in case it might come up on a test). Finally, the PPI believes that, although individual mastery is important, students need to learn to collaborate, as it improves individual learning. The approach taken in one of the courses offered in the Computer and Information Technology (CIT) curriculum, CNIT 390 Supervised Practicum, falls directly in line with the values and beliefs articulated by Purdue Polytechnic Institute. The following sections will review the use and reflections from two recent offerings of the course.

**CNIT 390 Course**

CNIT 390 Supervised Practicum is an instructor-directed course designed to combine university study with work experience directly related to the student's major. The class is a 3-credit hour course with credit awarded upon the completion of a department-approved project. The course is designed for undergraduate CIT students who desire to integrate both the theory and practice of information technology. The goal is that students will apply what they have learned in previous courses by implementing projects for real users, generally organizations within the community. The course is not new; it has been in the curriculum for years predating Purdue Moves and Purdue Polytechnic initiatives. CNIT 390 is not a required course in the curriculum, but a CIT elective. Because of that and the high amount of effort needed to find acceptable projects and clients, this course is not offered on a regular basis.

CNIT 390, although not created to be part of the Purdue Polytechnic, fits the PPI goals and concept very well. As we have already mentioned, PPI believes that learning is a personal act of discovery with faculty playing the role of supporting rather than driving the students' learning, values open-ended inquiries that have risks, intrinsically motivated students and the students' need to learn to collaborate in an effort to improve individual learning. The basic format of the class involved very limited instructor lecture, no textbooks, in both cases student managed projects with instructors acting as guides to the students, and students required to gain the knowledge of developing the applications outside of the normal classroom. The class has been offered twice at the Columbus campus, in 2013 and 2017. In the

following sections, we will review the course development, delivery of the course, client, and client project and evaluate the course looking at issues that occurred and lessons learned for each course and implications for future offerings of CNIT 390.

**2013 Section of CNIT 390**

*Insul-Coustic Quoting System Project*

The instructor solicited clients for a class project. The client selected for the project was Insul-Coustic, a manufacturing company out of Fort Wayne, Indiana.  The client was looking for a potential upgrade to an existing homegrown Excel based system to allow the staff to quote projects and manage existing projects.  The client made clear it that he would evaluate the end product and then decide if they would implement it.

*Format, Schedule and Delivery of the Course*

The class was offered in a format with class time reserved for two days a week over a traditional 16-week semester.  Days were reserved in case lecture was needed and to make sure students had a common time when they could meet as a team and with the client.  The class met in traditional format with lectures and discussion for the first two weeks to introduce the class, project, review the basic systems development approach to be taken in the class, and complete a skills assessment to determine team member strengths.  Throughout the rest of the semester, the students were required to create analysis, design and implementation deliverables and meet with the client and instructor with a goal to have the project completed by week 14 (deadline set by the instructor) of the semester with the last two weeks used for project review and lessons learned (and a little extra time in case the project required more time).

*Role of the Student, Client and Instructor*

The parties involved included the client, students and the instructor.  The client was Insul-Coustic. This class involved finding a client (unlike the next section of the class). In soliciting clients, a criterion was to find a company that would be willing to spend time with the students in their role of client on an IT project. For Insul-Coustic, one of the owners agreed to work with the students.  He made space in his schedule to work as a client on a regular basis.

The role of the instructor was to be responsible for evaluating the students for the purpose of determining a grade and in terms of the project more of a guidance role.  In order to do this, the instructor's role was more a person in charge of application development instead of a project manager. The student's role was setup as the IT group.  The goal was to cover all of the functions that would be required to run through the Systems Development Life Cycle.

*Evaluate Student Performance*

Planning to evaluate student performance created a challenge.  The goal was to make sure everyone was evaluated individually. To do this there was a combination of activities that involved not only the

instructor but also the students and clients in the evaluation process. Following are items that were chosen to evaluate students on:

> b. Writing assignments focusing on project reflection
> c. Project update memos
> d. Class assignments such as having each student fill out project time sheets weekly
> e. Client evaluations
> f. Peer evaluations
> g. CONOPS document
> h. Completed application with the documentation

### Results of the Development of the Insul-Coustic Quoting System Project

The original scope of the project was large and with the limited time and capabilities. The end product specifications were narrowed to develop a system to handle the quoting process. The class started with two teams performing the initial analysis and then combined to complete the development.

The approach the students decided to take was similar to the Agile or a System Prototyping where the goal was to work in short cycles to get something to the user to test, use and give feedback. Based on the project, user availability and length of the class they chose to work in two-week cycles. The students and client agreed on the scope and determined that if there was additional time at the end they could add features to the project. Based on the user requirements, the students chose to develop a web-based application written in PHP, JavaScript and HTML and using MySQL for the database. The system was completed and user tested within the timeframe of the semester although not on week 14 but closer to final week of the semester. Again, the client was looking at possible upgrades. At the end of the semester, the client chose not to implement the system. The main issue that the client had, which became apparent as the end of development, was that if implemented there was no support for the platform chosen (PHP, JavaScript and MySQL).

### Reflections on the Experience

From an instructor point of view, it was a new experience. The instructor role was much more the guide instead of leading the class. This was an adjustment. The class had a more heightened level of excitement, involvement and stress working with a live project as compared to working on "canned" projects. There seemed to be an added ownership as they were creating something that was going to be used in industry and they were not only trying to work for a grade in class but satisfy a client's requirements for a live system. Having said that, some students seemed to disappear into the group and not really participate except for the minimum required. Students noticeably took it upon themselves to search the internet for online tutorials, documentation, etc. on how to accomplish certain tasks that were critical to the project. The students understood this was an unstructured assignment and realized they were not going to be spoon-fed. One area that was difficult in the class was trying to evaluate student performance and to give them a grade. As mentioned, there were multiple assignments throughout the semester but it was difficult to get a feel for individual accomplishments in some cases.

The client filled out a questionnaire after the class on the experience. He stated that the students were interested in the project, inquisitive about the project details, and eager to perform tasks. The cost was minimal and gave Insul-Coustic a chance to evaluate a new concept without investing many resources

or much time. Students overall were dependable, skilled and worked well with each other. From a standpoint of things that could be improved, the main thing he mentioned was giving students more opportunities to work with "real" clients to have a better feel for questions to ask. Overall, the client was very pleased and expressed an interest in being involved again and possibly continuing this project into a later phase.

Students were surveyed about their experience on the project. Students tended to be pleased with their role on the project. They believed they were prepared to work on the project. Students overall felt they were utilized the right amount of time, although there were some who felt they were over utilized and they commented some students were underutilized. The live project led to a lot of real world experience that would have been hard to capture in a normal assignment, this was the most often-made comment from the students. The project gave students experience at working on various aspects of IT instead of, like in most classes where it is programming or systems analysis. Students were pleased with the setup of a student as project manager and the instructor as a guide. There were a few negative comments or suggestions about the project. On the Insul-Coustic project, it would have been nice if the students could have visited the company. For members who were not contributing, the lack of structure could be frustrating. Some students were working on parts of the project that made them feel secluded from the rest of the project. One student was disappointed the product was not used by the company (they were told that the project was a way for the client to evaluate a new concept).

**2017 Section of CNIT 390**

*Train Application Project*

In 2017 the city of Columbus Indiana approached Purdue about developing a new smartphone app that would monitor increased train traffic that is disrupting traffic on a main thoroughfare for the EMT, police and general public. The initial goal was to develop a smartphone application that all involved parties could use to get notifications about approaching train traffic. They wanted a system developed to go live as soon as possible. Figure 1 shows the locations of the SecurityPros cameras and a sample status of the key railroad crossings.
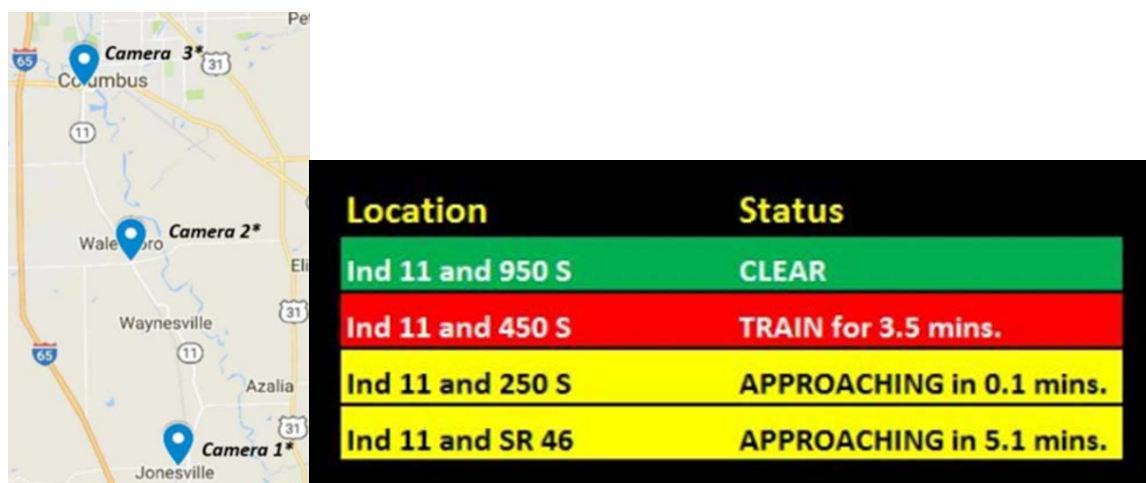


Fig. 1. The map and a sample status of the key railroad crossings

In August of 2017, shortly before the class was to begin, the scope of the project was changed for the students to develop a web app, i.e., a website with a mobile version accessible via the smartphone's browser.

### *Format, Schedule and Delivery of the Course*

The class met twice a week, in the conventional 16-week semester format. Lectures alternated with lab sessions devoted to the team project work. The course explored a wide variety of Web application development topics including the major components of the HTML5 — HTML, CSS, and JavaScript — along with traditional and mobile Web design, forms, and advanced topics, such as geolocation and the Google Maps API. Students were expected to use Adobe Dreamweaver, Adobe Photoshop, and Google Web Designer and produce accurately functioning Web apps meeting the given requirements. Most meetings with the client representative were scheduled to take place during the regular class time.

### *Role of the Student, Client and Instructor*

The instructor's role involved teaching front-end development in HTML5, evaluating the students' performance, and providing task formulation and general guidance on the team project. The semester project was an 'unstructured problem solving' experience, so the student team had to manage the project schedule. One of the four students enrolled took on the role of the project manager and contact person, another one concentrated on the front-end web app design and testing, the third student developed the back-end solution, and the other student dealt with the camera and server specification development. The latter task proved harder than the reader might expect, requiring coordination with the system administrators on campus. As a result, the dedicated server donated by the client arrived November 29, 2017, very late in the semester. Nevertheless, it was configured by the end of the semester, as the prior preparation work was done by the student responsible for the back-end development on his own private server.

### *Evaluate Student Performance*

Six homework assignments were given early on in the semester, ultimately contributing ~21% of the final grade. All of them were project-oriented and aimed at getting the project off the ground as quickly as possible. The students were also given the midterm and final exams. The largest single component of the final grade (~35%) was the team project grade that encompassed the project's functionality, documentation, and presentation. Student participation was taken into account as well. The instructor initially intended to take into consideration client evaluations, too; however, that plan was abandoned because the project was not completed by the end of the semester as originally estimated.

### *Results of the Development of the Columbus Train Tracker Project*

Given that the client liked the mock-up website design, a section of the CNIT 355 Software Development for Mobile Computers was added to the Spring 2018 semester schedule, and three out of four original student project participants took this course as well, along with one other CIT student. The project scope was extended to include development of an Android app that would access the Columbus Train Tracker website directly, bypassing the need to use a smartphone browser. By the end of the second semester, the team achievements were as follows.

1. An Android application prototype was developed and presented to the client.
2. The website was made accessible via Purdue VPN and tested to make sure that it received messages from SecurityPros cameras located near the railroad tracks and handled the messages appropriately.
3. The web server, database, and Java application were integrated.

### Reflections on the Experience

From the instructor's standpoint, the amount of work needed to learn back-end development in the situation when it was not taught in either of the two courses was greatly underestimated, but the student involved in it went above and beyond all expectations to get the job done. The front-end website and Android app development went just fine. The client was satisfied with the mock-up website and Android app prototype demos.

Four out of five student participants kindly agreed to fill out a questionnaire about the project experience. Regarding their respective roles on the project, one of the respondents reported being very pleased, another one pleased, a third one displeased, and the fourth one very displeased.

The very displeased student was the one responsible for configuring the web server using the Express/Node framework, the Java application used for reading from and interpreting emails from the cameras, the design and implementation of the database server to house all data, the server setup and administration (as well networking), and the integration of all these components with one another. This heroic student was definitely overworked, yet reported that he was under-utilized. He also considers himself overqualified in terms of his technical ability, and that rings true. The displeased student developed the prototype of the Android train-tracking app. He recognized that he was over-utilized, yet reported being underqualified, ostensibly in error or out of modesty. The students primarily criticized the lack of access to the stakeholders, along with the setbacks stemming from the late delivery of the cameras, server, rack, the networking issues, and numerous false positives from the cameras needing more calibration.

The pleased and very pleased students were the ones responsible for the hardware specifications and front-end website development. One of them opined that it was interesting to work "on a project that has application in the real world and can benefit the community."

### Evaluating the Courses

To evaluate the course you need to look at it from several viewpoints. From an instructor standpoint, it was a change from traditional classes and involved a different role as mentioned previously, more of a consulting, guiding role than that of a provider of a lecture-driven course. Both instructors felt the students picked up valuable knowledge and real-life experience that is hard to duplicate in the typical class. Most of the CIT classes focus on one area: system analysis, programming, networking or databases. These classes pulled all of these areas together and achieved even more by forcing students to get in and be true problem solvers in order to develop the applications and not have the instructor or book to rely on. In fact, in several cases the students surpassed the instructors' knowledge in areas needed to complete the project. In some cases, this was uncomfortable for the instructor but only natural on projects with far reaching scopes like these.

Examining the course from a student perspective, was it successful?  Overall, probably yes, but certainly not of equal value for all students. In a traditional classroom that would be true as well. One student put it aptly; this is not like the programming class where our first assignment is the "Hello World" program. One student specifically mentioned he thought that was the big advantage of this class not just focusing on one area of information technology because everyone has areas of strength and this allowed students in most cases to find their niche.  The enthusiasm of the students was evident to not only instructors but to the clients as well who noted that in their comments.

One real issue in both sections offered was that there were several students, who worked much more on the project than the other students. In the first section from 2013, it was two students and in the second section from 2017, it was one student.  In both cases, it was the students doing the majority of the coding in the implementation stage.  All of the students involved were more than willing to take on the work, even mentioned that they enjoyed the challenge, but it did get to a point specifically in the latest offering of the class that faculty and students met because it was having a detrimental effect on the students' other courses that semester. In both cases, it was not that the other students were unwilling to code, but it was difficult to get the other students up to speed where they could be productive. The tight schedules made it difficult for the students doing the coding to take the time to get others up to speed.

In future offerings it would be helpful to figure out a way to reduce overloading students on the project. Overloading can be especially detrimental to a student if it occurs at the end of the semester, when the student is finishing other courses as well. This was even more stressful to the students because they were trying to satisfy the instructor, but also a client who wanted to use the finished product. For other students, there were periods when they were under-utilized, especially in the case of the 2013 class with eight students in it.

It was extremely helpful to have the clients we had.  The time and resources they devoted to the project were generous.  The biggest area of difference in the two courses were the clients' goals and expectations for the developed systems.

In the 2013 project, the client expectations were lower and goals of the client relieved some of the pressure of developing the system. As mentioned previously the client's goal was to look at an alternative to their current system.  In the analysis phase it was determined there was not enough time in a one-semester class to accomplish the initial goals and the scope of the project was scaled back with complete agreement from the client. When the project was completed at the end of the semester the client tested the system and chose to keep their existing system.

The 2017 section of the course had completely different goals and expectations.  Unlike the first course where clients were sought out, the City of Columbus, Indiana, came to Purdue with a problem that they needed resolved. From initial meetings it was clear that expectations were high from the city representatives and from Purdue.  For Purdue this was a chance to showcase what Purdue Polytechnic was about and advertise Purdue Polytechnic in Columbus and our program specifically. Initial meetings with CIT faculty, Purdue administration and Columbus in the spring of 2017 raised expectations.  From those initial meetings it was determined that the users first wanted a website and then would want apps for Android and iOS devices created.  The scope had increased so that it could not be accomplished in a one-semester class with four students enrolled.

Showing the importance and desire to accommodate the clients, Purdue added a second class that most of the students enrolled in the spring 2018, CNIT 355 Software Development for Mobile Computers. Even with this class, the project could not be completed by the end of the second semester and other alternatives are being reviewed such as possibly hiring one or two of the students to finish the project.

Meanwhile, the word of the project leaked and it was publicized in the local newspaper, Indianapolis television station and on the main campus at West Lafayette. All of this was great publicity but also increased the pressure on the project participants. At the present time, the website has been successfully tested. A dedicated server is installed in the client-donated server rack housed in the Networking Lab, and the server's capability to receive and handle messages from the cameras that perform train detection was demonstrated. Website accessibility was established and maintained through Purdue VPN (Virtual Private Network). An Android application prototype was developed and presented to the client. However, the website and the Android app have not been made available to the public yet. There are complications that are still being resolved including insufficient reliability of train detection by the cameras on the tracks (too many false alarms) and internal networking issues (letting the public access the website without having to go through the VPN). At this point, the project is still ongoing, as the City of Columbus expressed the intent to hire a student who would maintain the train app server.

## Conclusions

The second offering of the CNIT 390 Supervised Practicum in 2017 was able to expose potential issues with offering live projects. The biggest issue is that expectations need to be managed and contingencies need to be in place. This includes expectations of all involved especially the clients. The scope of both projects exceeded the timeframe allotted – a school semester. In the first case, because of the flexibility of the client, the scope of the project was decreased and the project was finished in the semester. In the second instance, the scope was not reduced, but the timeframe was increased to allow for the development of the smartphone application. Normally, it would not be possible to add a class because this meant changing the sequencing of CIT classes and, with only two full-time instructors, this could make it more difficult to offer the classes that students need to graduate. However, because of the publicity, this was an option.

As instructors, we emphasize that these are students working on the projects as we attempt to lower expectations, but when clients see prototypes (even non-working ones), their expectations rise. Consequently, it is critically important to have a contingency plan that the clients are aware of and agree to.

The second issue that arose in both offerings of the class was the unequal workload that existed within the project, with some students overloaded. In both cases, the overloaded students were doing the majority of the programming. There is no clear answer to this dilemma. The possible options include pair programming and/or having extra students shadow the programmers (as a backup) to the extent possible.

Finally, the size of the class must be managed in order to find a way to utilize all of the students involved. The larger project teams used in the first semester caused more students to be underutilized. However, the use of competing teams alleviated that problem somewhat. In addition to that, having smaller backup projects that students could work on when they were not needed on the main project helped as well.

At this point, the projects appear to be a success, even though the second project is ongoing. This format was a learning experience for not only the students but also the instructors. It has also proven to be a positive experience for the clients and one in which CIT can continue. It requires careful selection of clients and project scope, but delivers a good learning experience for the students.

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