Clovis Community College Puts Industry 4.0 Into The Hands Of Students & Teachers

NSF-Funded Project Offers A Powerful Combination Of Ignition And Accessible Hardware

Next to the robotic arms, the off-the-shelf smart homes may not appear to be a key part of Clovis Community College's Automation, Robotics & Mechatronics lab, but this unassuming hardware is providing students and instructors alike with a unique opportunity to build industry-grade automation applications.

Located in Fresno, California, Clovis Community College is well regarded for its high transfer rate to four-year institutions. Now, by incorporating Ignition into its curriculum, Clovis is giving students in its Automation, Robotics & Mechatronics program the tools to develop a multifaceted skillset suited to both future higher-learning endeavors and local industry.

Project Development

Matthew Graff, Instructor of Automation, Robotics & Mechatronics at Clovis, was approached by a colleague from Texas A&M University about a grant from the National Science Foundation (NFS) to train high school and college students, as well as instructors, about technology related to the fourth industrial revolution. And, unlike programs that are only able to offer exposure to these concepts, this NSF funding would allow Graff to pay his student researchers.

In the Industry 4.0 Project, students develop an Ignition system that controls a miniature Keyestudio IoT smart home through a combination of a Raspberry Pi and ESP32 Arduinos.

Graff developed what has been dubbed the "Industry 4.0 Project." The idea was simple: combine Inductive Automation's Ignition software — an industrial automation platform for SCADA, HMI, IIoT, and more — with accessible hardware so that students could see immediate real-world results and be inspired to pursue careers in automation.

While developing this curriculum, Graff took inspiration from Walker Reynold's idea of creating a Unified Namespace (UNS) using a Raspberry Pi. "The idea of using really cheap hardware, Raspberry Pi and Arduinos, to run industrial software made a lot of sense for us in the project," said Graff. "We wanted something that would be very much hands-on."

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– Matthew Graff
Instructor of Automation, Robotics & Mechatronics, Clovis Community College

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There was just one problem — Graff had no background in working with Raspberry Pis, so he reached out to Bill Kerney, Computer Science Instructor at Clovis. While Kerney describes himself as "not an Ignition user," his expertise with Linux provided a complementary skillset. "My role here was as an advisor," he said. "I was here to supervise the student workers on the project, and so when they got stuck figuring out how to do something, then it was my job to unstick them."

Educational Engagement Program

While Graff had an easy time acquiring the hardware for the project, budgetary constraints prevented him from purchasing full Ignition licenses. Originally, the labs used Ignition in free trial mode, resetting the license every two hours.

When Graff, who has had frustrating experiences with other software companies, learned about Inductive Automation's Educational Engagement Program (EEP), he sent an email without expecting much, but was surprised to receive a prompt response. "I just got on the website and said, 'Hey, I'm interested,' and within a week, we were talking, person to person," Graff said. Beyond the licenses, the EEP connected him with experts at Inductive Automation to ensure the Industry 4.0 Project met industry standards.

Graff felt his experience was based on a shared ethos. "There's an understanding from Inductive Automation that there's a need to train employees, and they see us as partners," he said.

Industry 4.0 Project

In the Industry 4.0 Project, students develop an Ignition system that controls a miniature Keyestudio IoT smart home through a combination of a Raspberry Pi and ESP32 Arduinos. Students first set up an MQTT broker using Cirrus Link's MQTT Transmission Module, which they connect to their edge devices, meaning the smart homes. Next, students establish a UNS, following the ISA-95 standard, to connect to the MQTT broker. Once all the edge devices are publishing to the specific topics, students use the MQTT Engine Module to subscribe to those topics and bring the data into Ignition, creating tags. With these tags, students can build Perspective views and dashboards to display the real-time data.

The system is built in Perspective, meaning that when Graff gives demonstrations for high school students, he can have the class scan a QR code to gain immediate access to the application through their phones, upending the typical "no phones in class" rule. As Graff sees it, "I think a lot of times,

there's the difficulty of how we make technology used for a positive thing."

And with the combination of Ignition and smart homes, the positive results arrive quickly. "They can open up the box and hopefully within a class period, 45 minutes or an hour, have something working. They're pushing buttons and seeing responses. And so in that, immediately, they're learning some basic things like setup, using the Unified Namespace," said Graff.

The collegiate counterparts replace the Raspberry Pi with more professional hardware, courtesy of Opto 22. The combination of Ignition and Opto 22's groov RIO has been inspiring to the Clovis students. "Computer science majors oftentimes will live in this sort of platonic world of ideals and algorithms that are very abstract," said Kerney. "Getting them to actually turn a motor on or to turn a light on or to open a door is oftentimes just a mind-blowing experience for them."

Julian Laxamana, a student researcher working on the Industry 4.0 Project, found the ability to bring his programming into a tangible realm extremely gratifying. "It's really easy to have all your data in one place, which is really nuanced because if you make it by scratch, you have to have each computer send data, and you have to get it to show up on some GUI, which is really hard to get set up. But Ignition makes that a lot easier to link up all the data from the sensors to the computer," said Laxamana.

Laxamana, who had no previous Ignition experience, also integrated the Ignition system with a camera that analyzes its video feed in (almost) real time. "We currently use YOLOv8 to collect data from ESP32 cameras, process it through the Raspberry Pi, and then display it on a web page, which Ignition gets the data from."

Graff, who has strived to make the Industry 4.0 Project a "student-centered teaching system," was ecstatic to see his student taking initiative with Ignition, saying, "I just showed Julian a few things. And then the next thing I know, he's brought a video in with object detection that's run on another application."

Kerney agrees that it's exciting to see Ignition acting as a catalyst for students. "Most computer science majors, if you told them, 'Make a smart house that the door opens and closes,' and has all these sensors, they won't even know where to begin, but with Ignition in it they were able to get this whole system up and running in a pretty fast amount of time."

Transition To Industry

Entering its second year, the Industry 4.0 Project has already led to real-world success for students.

Gurkaran Singh, a student worker at Clovis studying industrial automation, was one of the main driving forces behind the Industry 4.0 Project, but most of his experience came from working on the project itself. "Before I came to Clovis, I had limited experience in industrial automation. I had only done one PLC programming class, and I had never heard about MQTT or SCADA or Ignition," said Singh.

Even without prior Ignition experience, between free resources like Inductive University and the Ignition user manual, Singh quickly discovered the breadth of functionality he could develop in the platform. “One thing I really liked about Ignition early on was how easy it was to download and set up on my own personal computer, to begin learning,” he said.

To gain a better understanding of the groov product line, Graff and Singh traveled to Opto 22’s headquarters in Temecula for a four-day training course. During the training, Singh learned about Farm Data Systems (FDS), an integrator specializing in agricultural automation and monitoring, utilizing a combination of Ignition and Opto 22 hardware. FDS uses its Water Informatics product to monitor and control irrigation for thousands of sites. “With Ignition, we've been able to really turn the corner for our customers in terms of giving them many systems and features that they've never had access to before. It's been quite revolutionary for our growers,” said John Williamson, President of FDS.

What piqued Singh’s interest was that FDS’ office was located in Madera, about a 40-minute drive from Clovis’ campus. With guidance from Graff, Singh emailed Williamson, expressing his interest in a job and citing his experience working with Ignition and Opto 22 products in the Industry 4.0 Project. Williamson was impressed and offered Singh a position, saying, “His career objectives were very much in line with what we were doing. So we met in person, and I already knew he could add value on day one. His training at college was really so well suited to the work we're doing here.”

Even in his first few months of employment, Singh is already helping Williamson to design Ignition interfaces based on customer requirements, configure PLCs, and build panels for field deployment in addition to daily concerns like alerts from customer sites. “My day to day over at Farm Data Systems includes configuring Opto 22 products for upcoming projects, monitoring alarms for the products that are already out in the field, trying to troubleshoot any networking issues that we face, and trying to help customers solve those problems,” said Singh.

“It's been really a remarkable experience for us to work with Ignition,” said Williamson. “The product that we bring to the market is just leaps and bounds ahead of anything anybody else can provide to help farmers do their job.”

Real-World Skills

The Industry 4.0 Project helps students build a foundation based on technical experience and critical thinking skills that are so vital in industry. Troubleshooting, in particular, can be the crux of any real-world system. “What we realized with this project is automatically just connecting a bunch of things using standard industrial protocols for Ethernet, there's a bunch of troubleshooting that has to happen even if everything's working,” said Graff.

The combination of software and hardware gives students the space to learn what to do when a system doesn’t work, which can be

more valuable long term. “Using hardware, you have the opportunity to make more mistakes. It may be a wiring issue or it could be a software issue such as setting an incorrect IP address. It helps you gain a deeper understanding of the whole system,” said Singh.

Additionally, the project puts many of the automation and computer science concepts taught at Clovis into the context of a complete system. “While working in industrial automation, at some point, you're gonna come across a problem where you need to integrate different devices, using different communication protocols,” said Singh. “Ignition is a really useful tool, in bringing all those different devices from different protocols together and utilizing that data to store, analyze, and generate some useful insights, and even building HMI displays for control.”

“I see Ignition as being a Rosetta Stone, and that's how I describe it to students where it can translate and connect all kinds of components together in a factory,” said Graff.

Sharing This Knowledge

Over the past year, the Industry 4.0 Project has expanded to five other colleges and 10 high schools, with plans to include five additional colleges and seven more high schools in the coming year. For Graff, sharing the project with other schools is about reaching the next generation of engineers. “A lot of high school students don't realize there's jobs related to industrial automation, and they could go into the engineering or computer science pathway,” he said.

“We've had three software engineers working on this project. The first one, Neiro Cabrera, worked on this for about a year and then he transferred to UCLA and then he just recently messaged me and told me that he got a job in a related industry,” said Kerney. “An absolute success story. He worked on this. He got experience in it. He found he loved it.”

This sense of discovery is a sentiment that Singh echoes. “When I first joined the industrial automation program here at Clovis Community College, my career goal was to be on the plant floor,” he said. “Working with this project has exposed me to newer and emerging technologies and broadened my horizon and opened me to a lot more opportunities within the field.”

Clovis does not want to gatekeep this knowledge or technology. In an effort to increase the accessibility of the project, Graff and Kerney set up a Github page that details the hardware and software requirements for the project, along with instructions for configuring components as well as lab exercises and training materials. “We want to share everything we have here,” said Graff. “You can take this and use it in a classroom. Or if you're just someone that wants to have a fun automation project, maybe before you hook up your whole home to be a smart home, you can just get a little $55 home from Amazon and pay $100 for a Raspberry Pi, and you'll be set to go.”

Clovis Community College is the state's 113th community college and joins Fresno City College, Reedley College, and Madera Community College as part of State Center Community College District. Clovis holds true to its goal and mission statement of "Creating Opportunities – One Student at a Time." This goal is achieved with a highly qualified staff of educators and support personnel who reflect the diversity of its unique community and embrace a flexible attitude toward change and encourage the spirit of innovation. Learn more at cloviscollege.edu.