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ISE students help deliver a shot in the arm

Data analysis, logistics used to set up Iowa State vaccination clinic

By Keith Albertson

Just as the COVID-19 pandemic brought massive societal disruption, the antidote for the deadly virus created its own unique challenges. As vaccines became widely available early in 2021, process improvement experts faced the logistics task of learning how to distribute them on a large scale.

One high priority location was on college campuses, where many students and faculty weary of a year of remote learning and social distancing were anxious to receive their shots quickly and efficiently so they could attend graduation ceremonies and other gatherings at the end of spring semester.

To streamline such operations, a team of industrial and systems engineering students at Iowa State University collaborated with the school's Emergency Operations Center for procedures to help administer the shots effectively at a central mass vaccination site on campus.

The student group included undergraduates Tyler Brenza, Grace Nashleanas, Colton Richardson and Sam Schwierking,

Industrial engineering students helped design Iowa State's mass vaccination clinic at State Gym.

Photo courtesy of Christopher Gannon | Iowa State University News Service

An ISU student receives a COVID-19 vaccine at Iowa State's mass vaccination clinic at State Gym.

with Ph.D. student Ghazal Shah Abadi as project manager. All are part of an undergraduate research program led by Sarah Ryan, an industrial and systems engineering professor and IISE fellow.

The goal of the university's emergency operations department was to move the vaccinations to a single site to maximize the number of shots delivered. The students began by studying data from smaller clinics operating in late March. They analyzed wait times along each step of the process to devise a queueing network model and determined that the clinic could vaccinate more than 2,000 people per day.

Schwierking, a junior and undergraduate research assistant in industrial and manufacturing systems engineering, told *ISE* that efforts to move people quickly through lines at the vaccination site relied on collecting data involving several time measures. Those included when people arrived for their appointment, how long it took to register, their arrival and departure at each station and how many registration areas were being used.

They factored in potential time delays along the way. While the vaccination itself can be administered in as little as five minutes, planners had to account for variables such as late arrivals and delays patients might encounter at registration stations. Because the vaccines must be prepared in advance and can be spoiled if not delivered in time, the goal was to move people as quickly and efficiently as possible.

The team also worked to ensure there was enough space set aside for people waiting 15 minutes at a post-vaccine observation station to be monitored for any allergic reactions. They measured the number of patients at a time every minute for the 15 minutes to calculate the amount of space needed.

"One of the delay factors that we had seen when looking at the minor clinic was if there were technical issues or a large group of people coming into the clinic at once. Both of these issues would force a backup in the queueing line before the entrance," Schwierking said. "Then once they started pushing people through as fast as they could, the number of people in the observation section would increase, and their number of chairs would be too low. So we recommended that they would have additional seating areas for these two cases. Actually, during the first few days of the clinic opening, this specific recommendation seemed vital to the operation."

"With a queueing network model, we get a glimpse ahead at issues they might confront so they can make adjustments on

Photo courtesy of Grace Nashleanas

From left, Iowa State University industrial engineering students, from left, Grace Nashleanas, Sam Schwierking, Tyler Brenza and Colton Richardson, industrial engineering professor Sarah Ryan and Ph.D. student and project manager Ghazal Shah Abadi.

the fly," Brenza, a junior majoring in industrial engineering, told *The Iowa State News Service*.

With the processes in place, the clinic began serving the university population April 20 at State Gym. Once the clinic began dispensing vaccines, the team observed the results and sought to make any necessary adjustments based on changing needs.

"Actually, the clinic went well," Schwierking said. "We made most of the adjustments before the clinic's opening because of the statistical analysis that we did. For instance, using queueing theory, we discovered that the sticker dispenser station, where people get what registration and vaccination station they are supposed to go to, was understaffed. So we adjusted accordingly, and I believe, got rid of that function altogether to make sure it wasn't backing up the process."

"With any research project, you typically start out with some objectives, then things change along the way and you have to adjust as you go," Ryan told *ISU News Service*. "I was worried the students would be frustrated by that, but I was encouraged that they understand this clinic has to adapt to events as they happen."

Through the end of May, the university had served nearly 6,800 patients and delivered more than 12,000 vaccines. The school planned to reopen clinics in August in time for fall semester.

"I got vaccinated the same day we had done observations. It's weird how different the patients see it versus how we're observing it," Richardson, sophomore in industrial engineering, told the *ISU New Service*.

Schwierking said he received positive feedback from those served at the clinics who had a positive experience.

"I heard many quality responses, personally," he said. "I know the people we were working with within the Environmental Health and Safety department were very grateful for having our help in trying to make sure that it went correctly the first time. I heard no complaints about the wait being long or unclear where to go next. So all in all, I think it was a success."

"I'm really glad we got to work with these students," ISU Emergency Manager Clayton Oliver told the *ISU News Service*. "This was a way for them to contribute directly to the solution."

In addition to helping get more shots in arms, the project gave the students a chance to apply ISE principles they learned in class to tackle a real-world challenge.

"This idea was foreign to the rest of my team and me before the project," Schwierking said. "So it we received the opportunity to expand on something even outside the studies that we have been given to that point and use some of the higher-level skills that we have learned in classes, like matrices.

"I think that it was a wonderful experience. I am not quite sure what I want to do in industrial engineering yet, but being a part of this project helped me understand the process side. I thought it wouldn't be something that I would consider, but this subset of IE allows me to touch so many different people in different ways." ❖

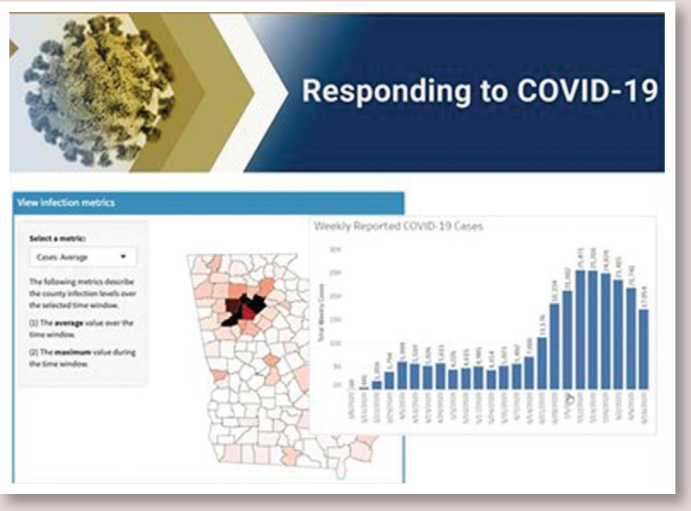
Keith Albertson is managing editor of ISE *magazine.*

Dashboard helps track vaccination levels

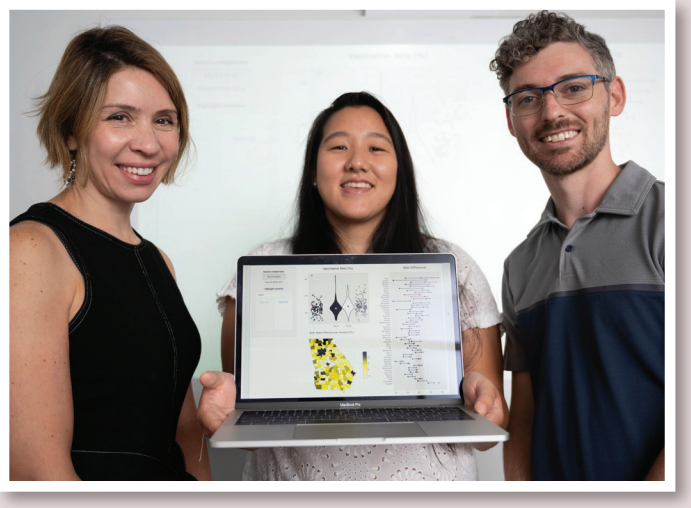
As COVID-19 vaccines are delivered, the next step for healthcare directors and process improvement experts is to gather data on who has received the shots, mostly to determine who is not getting the vaccines and how to reach them.

As of late June, more than 66% of U.S. adults had received their full vaccines, according to the U.S. Centers for Disease Control and Prevention (*covid.cdc.gov*), leaving a third of the population unvaccinated. The percentage of people who have been immunized can vary widely by region and demographics.

To monitor this data in their state, a research team at Georgia Tech assembled a dashboard to measure and display vaccination rates that can be divided by county, race and age, according to *Georgia Tech Research Horizons* (*rh.gatech.edu*). The Georgia COVID-19 Vaccine Dashboard includes interactive maps and tables that compare and rank counties by vaccination rates, social vulnerability index and other indicators.



A sample screen shot of the Georgia COVID-19 Vaccine Dashboard.



The research team behind the COVID-19 Vaccine Dashboard includes, from left, Center for Health and Humanitarian Systems Research Director Dima Nazzal, an IISE member, and Ph.D. students Akane Fujimoto and Tyler Perini.

Photos courtesy of Georgia Tech Research Horizons

"There is a lot variability in different regions of the state, so we wanted to take a closer look from an equity perspective," said Pinar Keskinocak, an IISE member, the William W. George chair and professor in the H. Milton Stewart School of Industrial and Systems Engineering at Georgia Tech and co-founder and director of the Center for Health and Humanitarian Systems, an interdisciplinary research center at Georgia Tech.

Georgia Tech's research team includes Ph.D. students Akane Fujimoto and Tyler Perini and CHHS Research Director Dima Nazzal, an IISE member. They worked with the Georgia Department of Public Health (DPH) to set up the dashboard. They share early versions of it with the DPH and the Georgia COVID-19 Health Equity Council.

The dashboard concept is key to helping specific areas achieve full herd immunity. Even as vaccination rates rise overall, targeting areas that fall short of achieving such immunity is key. It also helps divulge what socioeconomic factors might be involved in keeping rates low. Its totals as of early June showed that vaccination rates were higher among white residents in large metro area counties and in about 70% of counties overall.

Nazzal said the dashboard shows lower rates overall in areas below the poverty level compared to the national average. Some counties showed higher vaccination rates among white residents, particularly in large urban counties, while the vaccination rate is higher among Black residents in a few counties.

A CDC Morbidity and Mortality Weekly Report (MMWR) released in late May showed vaccination rates lower among adults in counties with the highest social vulnerability, such as lower socioeconomic status, households with children, single parents and persons with disabilities.