

Rapid Respo

U of I researchers and faculty combine their talents and battle COVID-19—from modeling the disease’s spread and symptoms to manufacturing hand-sanitizer, and designing tests and life-saving medical equipments | By Cindy Kuzma

As the SARS-CoV-2 virus spread globally, scientists at Illinois leapt into action, collaborating across disciplines and continents and forging ahead at warp speed. Here’s a look at what they achieved in U of I labs, via Slack and Zoom chats and at faculty members’ kitchen tables.

Guiding public policy

Professors Nigel Goldenfeld and Sergei Maslov, colleagues at the University’s Carl R. Woese Institute for Genomic Biology, work together on applying concepts ranging from physics to life sciences. Their offices are adjacent, so “it was a no-brainer to collaborate on what we could see was going to be a massive crisis unless the authorities acted,” Maslov says.

They aimed to solve a key question facing Illinois leaders: Was there any way to avoid overwhelming the state’s intensive care units with COVID-19 patients?

Over weeks of 18-hour Zoom video calls, the pair consulted with colleagues—including theoretical physicists, civil engineers and epidemiologists—to calibrate computer simulations and map the virus’s potential spread, estimating its effect on Chicago-area hospital utilization.

Their findings? If Gov. J.B. Pritzker implemented stringent measures—such as a shelter-in-place order—by April 1, about 1,151 Illinoisans would die from COVID-19. But if he waited until April 20, that peak would exceed available ICU beds by tenfold, increasing the death toll to a projected 7,445 victims.

Pritzker cited the scientists’ work when he closed Illinois schools on March 13, and again on March

20, when he announced that the state’s stay-at-home order would begin the following day. In the days and weeks that followed, Goldenfeld and Maslov remained constantly at their computers, tracking data and sending updated projections to Pritzker’s office. And on April 23, they came to his daily press conference and explained how their calculations had led Pritzker to extend and modify the stay-at-home order through May 30—a move that they say likely saved thousands more lives.

“This University is rather special in its combination of brilliant faculty and students,” Maslov says. “While my colleagues at other universities were salivating at the prospect of writing grant proposals for COVID-19, many of us here at Illinois were doing something for the common good.”

Producing virus-fighting sanitizer

Staffers at the U of I’s Integrated Bioprocessing Research Laboratory put that altruism to even more immediate use. Although the lab’s 10,000-square-foot processing plant serves as a testing ground for food products, including new beverages and meat alternatives, they shifted their normal operations to a more pressing priority: producing hand sanitizer. “We had our first batch of sanitizer out the door within a week,” says **Brian Jacobson, ’10 ACES**, the lab’s assistant director of food and bioprocessing pilot plant operations.

Mixing the compounds was the easy part. Far harder, Jacobson says, was acquiring the ingredients. A campus-wide call for hydrogen peroxide

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and glycerol brought in enough supplies to produce many batches of sanitizer, but the ethanol needed to effectively kill germs proved harder to come by.

At first, the on-campus chemistry store tracked down one 55-gallon drum of ethanol at a time. Jacobson and three staffers split their time between working at home and rushing to the lab to brew a sanitizer batch. By mid-April, they'd produced about 1,200 gallons of the virus-killing compound.

Then an ethanol company donated 5,000 gallons, which made 6,000 more gallons of sanitizer. The Illinois Fire Service Institute and the joint U of I/Champaign County Emergency Operations Center then distributed the crucial supply to local first responders and health care facilities.

Jacobson and his team were glad to help. He's not only a staff member and an alumnus, he's also a student—he'll soon complete his master's degree in food science. "These are the types of things that make me proud to be an Illini," Jacobson says. "In such a horrible time, this was a great opportunity to give back."

Applying the powers of supercomputing

Whether it's modeling how COVID-19 is transmitted, reading CT scans of patients' lungs or optimizing newly remote workforces, navigating the pandemic world also depends on data, in volumes that often exceed traditional computing bandwidth.

That's where the newly formed C3.ai Digital Transformation Institute comes in. The Institute is awarding research grants and access to computing resources—including the Blue Waters supercomputer, housed at the National Center for Supercomputing Applications at Illinois—in order to accelerate changes in business, government and society needed to address the pandemic.

The Institute is backed largely by **Thomas Siebel**, '75 LAS, MBA '83, MS '85 ENG, HON '06, founder and CEO of artificial intelligence company C3.ai. **Rayadurgam Srikant**, MS '88 ENG, PHD '91 ENG, the Institute's co-director and U of I professor of electrical and computer engineering, says the facility was originally scheduled to open this summer. But that opening was expedited, with the Institute issuing its first call for grant proposals on artificial intelligence techniques for mitigating the pandemic on March 26.

For Srikant, that's meant working closely with his co-director at the University of California, Berke-



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ley, S. Shankar Sastry, professor of electrical and computer sciences, and a leadership team that includes Siebel, former Secretary of State Condoleezza Rice and Tandy Warnow, a U of I professor of bioengineering and computer science and one of the Institute's chief scientists.

In its first five years, the Institute plans to distribute \$367 million through as many as 26 grants annually. Each may comprise as much as \$500,000, and will include computing resources. The Institute also will host visiting scholars and produce educational programs, among other efforts.

COVID-19 proposals were due May 1, with an intentionally broad call, open to everything from drug design and testing strategies to ways to improve societal resilience. "We don't want to prescribe solutions," Srikant says.

Given the high-caliber institutions and scientists involved, he has little doubt they will rise to the occasion. Srikant proudly cites the quote Siebel gave to *The New York Times*: "The probability of something good not coming out of this is zero."

Designing critical medical supplies

Patients who are severely ill with COVID-19 often require help breathing. As the pandemic worsened, officials at Carle Health system in Urbana began preparing for scenarios in which there was a shortage of hundreds of ventilators. "Most people in that

(Above) Carl R. Woese Institute for Genomic Biology Professors Nigel Goldenfeld (shown) and Sergei Maslov discuss their work modeling the spread of COVID-19 in Illinois at Gov. J.B. Pritzker's press conference and the need to extend the stay-at-home order through May 30.

(Top right) Staff at the Integrated Bioprocessing Research Laboratory used their expertise to produce more than 7,000 gallons of hand sanitizer for distribution to first responders and health-care workers.

(Center) The C3.ai Digital Transformation Institute, co-directed by U of I professor Rayadurgam Srikant, is providing grants and access to the Blue Waters supercomputer to COVID-19 researchers to expedite



Courtesy of Brian Jacobson

conversation were engineers,” says William King, a professor of mechanical science and engineering. “When we see a problem, we assume there’s something we can do to fix it.”

So at 8 a.m. on March 16, a 40-plus-member team assembled to do just that. They included representatives from the Siebel Center for Design at Illinois, Grainger College of



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Carle Illinois College of Medicine Health Maker Lab

Engineering, the Applied Research Institute and area businesses, among others.

The group began by studying breathing devices already on the market, including emergency ventilators. The latter aren’t intended to replace hospital-grade devices, but are used in urgent situations such as when a first responder arrives.

Project manager King and his colleagues attempted to acquire an emergency ventilator, but

found distributors out of stock and manufacturers unresponsive. “So we set about designing our own,” he says. The group broke into teams to tackle the ventilator’s design, testing and user interface. Once a basic structure emerged, they used additive manufacturing—better known as 3D printing—to build and rebuild it. “By Sunday afternoon, March 22—160 hours after the project began—we had a prototype that worked,” King says.

The resulting small plastic device, called the Illinois RapidVent, looks simple, but lasts 75 hours or 125,000 breathing cycles. “The head of the ICU at Carle (Foundation) Hospital looked at the data

and said, “This device would save somebody’s life,” King recalls.

Next, the team fine-tuned RapidVent, setting the specific pressure levels and breathing rates required for COVID-19 patients. They then announced the prototype and made the technology freely available for licensing at rapidvent.grainger.illinois.edu. Several manufacturers have expressed interest, and King hopes that the technology will soon be approved by FDA, mass-produced and deployed.

“Something really special about the culture of U of I brought those people here—brilliant engineers and scientists and physicians, dedicated, high-character folks,” King says. “This emergency is not something any of us wanted. But it brought out the best in this group of extraordinary people.”

Meanwhile, another group from the Grainger College of Engineering joined forces with the Carle Illinois College of Medicine’s Health Maker Lab to design and produce 2,000 face shields for health-care workers on the outbreak’s front lines.

That effort was part of a larger U of I Personal Protective Equipment Design Initiative, which involved everyone from engineers to physicians to costume designers to alumni who donated funds via ippe.grainger.illinois.edu. Together, they designed and tested prototypes for N95 respirators, gowns, face shields, caps and sterilization technologies.

Tracking COVID-19 symptoms

Professor of food science and human nutrition Marta Yanina Pepino was already balancing online teaching, virtual meetings, adapting her research on taste and smell perception to stay-at-home restrictions—and with her fellow-scientist husband, supervising three elementary-school-aged children.

But in late March, she received an invitation she couldn’t refuse: to join the Global Consortium of Chemosensory Researchers, a 500-plus-member group investigating the sudden loss of taste and smell in COVID-19 patients.

Hallmark COVID-19 symptoms include cough, fever and shortness of breath. However, early reports suggest that 60 percent to 80 percent of patients also lose their ability to taste and smell, a much higher percentage than cold or flu sufferers.

Scientists aren’t yet sure why. Any illness affecting the respiratory system can cause nasal-passage inflammation. However, the same enzyme that allows the SARS-CoV-2 virus to enter and attack the lungs—called ACE2—also exists in the tissues to which odor molecules adhere, causing a loss of smell without a runny nose or congestion.

Many COVID-19 patients report this sensory loss earlier than other symptoms. Confirming this

their work on everything from drug design and testing strategies, to ways to improve societal resilience.

(Above) A 40-plus U of I team led by Professor William King developed RapidVent, an emergency ventilator that lasts 75 hours or 125,000 breathing cycles.

pattern could slow transmission if those who suffer from it are immediately tested for the coronavirus and/or self-isolate for two weeks.

Collaborating on the digital networking platform Slack, the consortium quickly designed a global survey on smell, taste and respiratory illnesses and received institutional review board approval to distribute it. Pepino, who's originally from Argentina, helped translate the questions into Spanish and disseminated the survey throughout South America.

She and two of her graduate students use Slack to stay in near-constant communication with the consortium, which includes top scientists in such fields as otolaryngology and neuroscience.

Thousands of participants have already taken the survey, and the results will likely lead to publications and more discoveries. "We are going to learn a lot about COVID-19—but this also will incentivize more research on smell and taste," Pepino says.

While tracking symptoms helps, testing for COVID-19 remains critical. To that end, Brian Cunningham, U of I professor of electrical and computer engineering, is working on several diagnostic technologies, including one that detects part of the virus' genome, transforming it into data readable via a smartphone app.

Meanwhile, faculty from the College of Veterinary Medicine's diagnostic laboratory have helped identify the virus in an entirely different category of patients—big cats at the Wildlife Conservation Society's Bronx Zoo in New York City.

The unexpected collaboration resulted from a test U of I veterinary virologist Leyi Wang had created to rapidly detect the coronavirus in animals.

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On April 1, Karen Terio, chief of the College's Zoological Pathology Program, received a call from a veterinary pathologist colleague at the Bronx Zoo describing a tiger that showed coronavirus-like symptoms. Nose and throat samples from the tiger were sent to Wang for testing; ultimately, the College's diagnostic lab director, Rick Fredrickson, personally drove the sick cat's samples, which tested positive for the virus, to the U.S. Dept. of Agriculture's National Veterinary Services Laboratory in Ames, Iowa, for final confirmation.

Discoveries for the future

All of these initiatives have played an important part in understanding and combating the COVID-19 pandemic. But the connections, technology and research findings they've yielded will likely serve the University community—and the world—in ways that will outlast the current crisis.

"The University has a history of interdisciplinary research, where we cut across boundaries from multiple sciences and humanities and arts and industry," Srikant says. The greater goal of that cross-disciplinary focus has always been to improve society—and that's something that won't change, even when COVID-19 is under control. ■

A loss of taste and smell is often an early symptom of COVID-19. U of I Professor Marta Yanina Pepino is part of the Global Consortium of Chemosensory Researchers that is conducting further studies into this phenomenon. Confirming this pattern could slow transmission if those who suffer such loss of taste and smell are tested quickly and/or self-isolate for two weeks.