CITRIS AND THE BANATAO INSTITUTE

UNIVERSITY OF CALIFORNIA

BERKELEY
DAVIS
MERCED
SANTA CRUZ

CITRIS Strategic Plan 2022-23

CITRIS and the Banatao Institute

CITRIS-UC.org

CITRIS Strategic Plan 2022–23 | Adopted May 15, 2022

Table of Contents

Executive Summary

Leading interdisciplinary IT research and discovery for a better world

For over 20 years, the Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS) at the University of California (UC) have catalyzed technology-driven solutions for the most pressing issues facing California and the world. Combining the complementary strengths of four UC campuses — Berkeley, Davis, Merced and Santa Cruz — our interdisciplinary approach to discovery and innovation is critical to meeting the needs and challenges of a diverse and changing planet.

Responding to profound social and societal transformations from advancing technology and effects of the COVID-19 pandemic, devastating wildfires and other extreme events, CITRIS continues to fulfill its public mission by addressing urgent issues in climate resilience, technology policy, food systems, health care delivery and inclusive workforce development in the face of automation.

This strategic plan outlines the priorities and aspirations that empower CITRIS to expand the frontiers of knowledge in an ever-evolving IT landscape and help drive innovation and economic growth for the public good. In support of our network of leading researchers, faculty, students and partners, we reaffirm our commitment as a convener and source of intellectual leadership, funding opportunities, research infrastructure, working groups, talent pipelines, flagship programs and world-class events.

This strategic plan is a living document, revisited and refreshed annually to respond to near-term priorities while providing a longer-term vision, with major revisions every three years. To ensure this plan serves to advance CITRIS's bold mission, a set of institute-wide indicators has been established to continuously assess our collective contributions to the UC system, the state of California and beyond.

CITRIS's four impact indicators will guide strategies and activities that:

1. **Catalyze interdisciplinary solutions** to complex societal challenges by leveraging our cross-campus excellence in information technology and its applications.
   Key indicator: Number of disciplines involved
2. **Foster faculty engagement** through CITRIS-sponsored research, reaching both emerging innovators and established experts.
   Key indicator: Number of faculty engaged

3. **Expand student discovery opportunities** within tomorrow's high-tech sectors.
   Key indicator: Number of students involved
4. **Broaden and increase fundraising** from industry, philanthropic and government sources.
   Key indicator: Total dollar amount of inbound funds

Directors and program leads will outline how their work contributes to the advancement of these four measures and report on progress every six months.

History and Governance

In 2000, California Governor Gray Davis sponsored the establishment of four multicampus Institutes for Science and Innovation at the University of California. With the generosity of leading businesses and private philanthropists, the foundation was laid for an unprecedented partnership to secure California's future economic and social development. CITRIS was created in 2001 as one of these four interdisciplinary institutes — later known as the Governor Gray Davis ISIs (GGDISI) — to shorten the pipeline between world-class laboratory research and the development of applications, platforms, companies and new industries.

Headquartered at UC Berkeley, CITRIS reports to the vice president for research and innovation at the UC Office of the President (UCOP) and by delegation to UC Berkeley's vice chancellor for research. CITRIS campus directors at Davis, Merced and Santa Cruz work closely with their respective vice chancellors of research and deans of engineering.

The CITRIS advisory board gathers three times a year to provide important insights and expertise, as well as strengthen relationships with partners in academia, industry and government. The board is chaired by CITRIS's founding benefactor and comprises leaders from UC campuses and UCOP, senior leadership at partner companies, and state government officials. CITRIS also engages faculty advisory councils twice a year at each of the four campuses to align on research directions, engage local faculty and collaborate on fundraising opportunities.

In addition, CITRIS convenes monthly meetings of the GGDISI directors to drive system-wide infrastructure and programs, and support UCOP Innovation and Entrepreneurship efforts to connect and mobilize innovators across UC.

Research Initiatives

CITRIS focuses on six research initiatives, grouped into the subcategories of Core Technology and Technology and Society: **CITRIS Aviation**, **CITRIS Climate**, **CITRIS Health**, **CITRIS People and Robots**, **CITRIS Policy Lab** and **EDGE in Tech**.

Leveraging these long-standing research strengths, CITRIS has the unique capacity to address unanticipated and emerging opportunities, including global emergencies such as the devastating effects of wildfire and the COVID-19 pandemic.

Through cross-initiative and cross-campus collaboration, CITRIS is bringing together researchers and students, industry partners and startups, policymakers and community organizations to make the University of California a global leader in the digital transformation of wildfire innovation, land management and community preparedness. This new focus will enhance the state's ability to prepare for and respond to wildfire and its exacerbating effects of climate change.

By utilizing existing infrastructure, CITRIS was able to make an immediate and lasting impact on pandemic response through the COVID-19 Seed Program that resulted in 97 proposals and 31 awards, as well as major donor support to fund these innovative technologies. During California's shelter-in-place order, the CITRIS Invention Lab provided maker space support for prototyping and production of personal protective equipment (PPE), ventilator adaptors and other materials needed by campus researchers and the broader community.

Core Technology

CITRIS catalyzes and develops new technology tools for near-term applications to address urgent global challenges.

CITRIS Aviation

CITRIS Aviation supports the interdisciplinary development of cutting-edge technologies, applications and policies related to vehicles for flight in order to generate societal and economic benefits for all. CITRIS Aviation harnesses the myriad opportunities provided by discoveries in propulsion, batteries and materials; applications of artificial intelligence (AI), automation and the Internet of Things (IoT); innovations in mapping and imaging technology; and more.

Priority areas of interest include:

- Leading-edge research investments
- Environmental monitoring
- Sustainable transportation and delivery
- Policy and regulation
- Equitable student engagement and workforce training
- Facilities and infrastructure

Priority projects include:

- Continue monthly CITRIS Aviation Working Group meetings of more than 60 faculty, staff and industry experts across UC Berkeley, UC Davis, UC Merced and UC Santa Cruz, and share opportunities in new listserv
- Recruit new CITRIS Aviation director for three-year term for this cross-campus, cross-disciplinary initiative
- Launch second CITRIS Aviation Prize in 2022 to create student research opportunities
- Continue to support tool development and training for environmental monitoring initiatives such as those focused on wildfire mitigation
- Partner with CITRIS Policy Lab and UC Center of Excellence on Unmanned Aircraft System Safety to identify and advance key aviation policies
- Continue fostering relationships with industry

Strategic goals for the next three to five years:

- Position initiative as a national leader in advancing cutting-edge technology research, applications and policies as evidenced by:
    - College rankings listing CITRIS campuses as top aviation and aerospace programs in the country
    - Aggregated cross-campus knowledge facilitated by CITRIS to catalyze transformative tech R&D (e.g., wildfire mitigation, decarbonizing air travel, managing airport traffic, drone delivery, air taxis)
    - At least one new Aviation-related policy enacted in California with CITRIS support
    - Industry using CITRIS UC airfields, eVTOL pads and other infrastructure
- Establish CITRIS as a connector (e.g., recent collaborative award from Caltrans to UC Berkeley, UC Davis and UC Merced researchers to analyze safety and policy implications of advanced air mobility)

CITRIS Climate

CITRIS Climate applies information technology to limit harm from climate change and build resilience for a sustainable, equitable and carbon-neutral future, with attention to issues of climate justice and equity to support underrepresented and underserved communities.

CITRIS Climate builds upon foundational work conducted in centers and research programs over 20 years, including:

- California Institute for Energy and Environment (CIEE)
- CITRIS i4energy Center
- CITRIS Sustainable Infrastructures initiative
- Climate Adaptation Research Center
- UC Water Security and Sustainability Research Initiative
- More than 80 seeded research projects in climate, air, water and built environment

Areas of interest include:

- Sustainable and affordable housing
- Sustainable adaptation of built environment
- Resilient and sustainable infrastructure
- Assessment and mitigation of climate-affected natural hazards (hurricanes, tornadoes, wildfires, floods, etc.)
- Integration of renewable resources in the electric grid
- Improving building controls
- Electric grid sensing, measurement and data analytics
- Community microgrids
- Electrification and decarbonization
- Digitalization of homes and commercial buildings
- Impact of building digitalization on air quality and health
- Interaction between climate, health and automatization
- Issues of climate justice, equity, diversity and inclusion

Priority projects include:

- The Oakland Ecoblock: a radical retrofit of existing residential homes to improve resilience, sustainability and quality of life for all community members
- Wildfire mitigation: UCOP Lab Fees-sponsored assessment and mitigation of wildfire-induced air pollution
- Brick: a metadata schema that improves interoperability among building controls, design, analysis and modeling
- Collaboration with CITRIS Health: climate-resilient healthy aging community, wildfire-induced air pollution mitigation
- Collaboration with MITRE/CITRIS Health: development of a joint index of natural hazards and health outcomes

- CITRIS Seed Awards: wildfire readiness for at-risk communities (UC Merced and UC Santa Cruz), optimizing e-fleets for farm operations (UC Merced and UC Davis)

Strategic goals for the next three to five years:

- Increase faculty opportunities such as cross-campus proposals and research, new centers and programs, and high-profile events and symposia
- Develop cross-disciplinary proposals demonstrating the alignment between climate resilience and climate sustainability
- Help UC achieve its carbon neutrality goals through the power of academic research
- Enable future workforce development and student opportunities through Cal Energy Corps, Workforce Innovation Program and experiential learning
- Expand awareness of climate solutions and enhance impact through CITRIS collaborations, especially CITRIS Health and EDGE in Tech

CITRIS Health

The goal of CITRIS Health is to unleash the potential of technology to improve health and quality of life while reducing health care costs, with a focus on improving health outcomes for at-risk populations and communities (e.g., older, low-income, rural). CITRIS Health builds from the rich academic base of the five campuses comprising CITRIS, including UC Davis Health, and differentiates its role by applying technology research in community settings. CITRIS Health serves as a convener and facilitator to connect and train researchers and students across campuses and disciplines through an ecosystem that engages health providers, payers, family caregivers and patients.

Building upon the foundational work developed at UC Davis Health and other CITRIS campuses, CITRIS Health researchers and innovators work with a diverse set of digital health technologies, including telehealth and remote monitoring, sensors and IoT, robotics, assistive technologies, and health informatics and machine intelligence (artificial intelligence/machine learning) to further our goals. The role of technology engagement is evident in several areas: identifying and testing new technologies, gathering data to measure the impact and value proposition, and accelerating the use and adoption of beneficial technology. Ultimately, CITRIS Health focuses on developing transformative, scalable and sustainable information technology-enabled solutions that shorten the pipeline between innovation, research and application.

Areas of interest include:

- Aging: chronic disease and wellness
- Precision public health

- Health care workforce and informal caregiving
- Digital literacy and access to technology
- Co-design technology innovation
- Digital health technology innovation
- Data-driven diagnostics and therapeutics
- Technology-enabled care delivery models
- Health informatics and machine intelligence

Priority projects include:

- Digital health technology innovation
    - ACTIVATE: refining and expanding telehealth digital health platform for community health centers nationally for low income and rural communities
    - Healthy Davis Together: disseminating lessons learned from comprehensive community-wide approach to interventions specific to mitigating the COVID-19 pandemic and find applications to other situations
    - Telehealth: expanding telehealth research and innovation (e.g., ACTIVATE, Lighthouse, TTRN Conference, MITRE Health Information Persuasion Exploration misinformation collaboration)
    - Healthy Central Valley Together: applying wastewater-based epidemiology in Central Valley cities
    - CITRIS Health/CITRIS Climate collaboration: designing climate-resilient healthy aging community; studying mitigation of wildfire-induced air pollution; developing joint index of natural hazards and health outcomes (with MITRE)
    - UC Davis Digital CoLab: collaborating with the CoLab to integrate new technologies into routine care for older adults including platforms and IoT sensors for care at home, chronic disease management and health coaching
    - UC Davis Health Cloud Innovation Center: leveraging new partnership with Amazon to incubate research projects around health equity in underserved communities around the globe
    - Engaging with industry partners to develop new co-design opportunities

- Healthy aging in a digital world
    - Learning laboratory for healthy aging communities: supporting the planning and development of a learning laboratory for aging communities, smart homes and health care providers (i.e., Folsom community)
    - Lighthouse for Older Adults: improving the well-being of low-income older adults through digital literacy and broadband connectivity
    - UC Davis Grand Challenges Health Aging in a Digital World initiative: supporting advances for improving quality of life for older adults (e.g., 2022 National Institutes of Health application to create of a new center that

explores the intersection of technology, cognition, caregiving and community)
    - UC aging and technology: supporting multicampus efforts including advising Betty Irene Moore School of Nursing faculty recruitment, engaging UC Davis executive leadership campus-wide strategic goal in aging, pursuing donor funding to establish endowed faculty positions, hosting Aging Research and Technology Innovation Summit
    - Student training: support training programs for students in career paths that include technology-enabled care

- Health informatics and machine intelligence
    - CITRIS/FAH-SYSU Health Informatics/Data Science Training and Research Program: expanding the program to additional students and fellows, across disciplines, CITRIS campuses and global partners (e.g., Pacific Rim Health Innovation Conference)
    - Machine Intelligence and Health Informatics Training and Research Program: expanding education and training for students in health information and machine intelligence, including pursuing donor funding for interdisciplinary programs

Strategic goals for the next three to five years:

- Expand innovative technology-enabled health care platforms and document the impact of innovation on the inputs and outcomes of care
- Expand interdisciplinary training and research initiatives for students across CITRIS campuses in healthy aging and health informatics and machine intelligence
- Serve as a learning laboratory and community for healthy aging research, innovation and training
- Collaborate with CITRIS initiatives on research (e.g., collaboration with CITRIS Climate and MITRE)
- Secure federal funding to support a new Center for Healthy Aging in a Digital World that will include training opportunities for graduate students and postdoctoral researchers across CITRIS
- Expand health care workforce expertise through health informatics and machine intelligence training and diversity, equity and inclusion (DEI) focus (e.g., CITRIS/FAH-SYSU fellowship program, CITRIS Health Information and Machine Intelligence Training and Research Program, CITRIS Workforce Innovation Program)
- Convene symposiums and forums in CITRIS Health thematic areas to advance knowledge in the field (e.g., Transatlantic Telehealth Research Network, Pacific Rim Health Innovation Conference and Aging Research and Technology Innovation conferences)

- Promote innovative multidisciplinary research through support of multicampus faculty and students (e.g., expand CITRIS Seed Awards; expand collaboration with UC incubators; support UC health start-ups; support Small Business Innovation Research, NIH, National Science Foundation, etc., proposals by CITRIS faculty)
- Influence state and national public policy impacting technology-enabled health care through publications and advisory bodies (e.g., CITRIS Policy Lab, CITRIS/MITRE HIPE disinformation program, California DHHS Data Exchange Framework)

CITRIS People and Robots

CITRIS People and Robots (CPAR) is advancing multidisciplinary robotics research with a focus on human-centric theory, benchmarks, software and approaches, in order to develop socially responsible technology for deployment worldwide.

Areas of interest include:

- Deep learning
- Cloud robotics
- Human-centric automation
- Precision agriculture
- Inclusive intelligence
- Bio-inspired robotics
- Socially responsible technology

Priority projects include:

- Formulate a vision for robotics in agriculture and food production (report)
- Organize a CITRIS-wide robotics in agriculture event
- Formulate a vision for inclusive robotics and automation (inclusive technology terminology white paper)
- Expand and link current efforts: Women in Robotics, Black in Robotics, etc.
- Pilot a public podcast

Strategic goals for the next three to five years:

- California is the largest food-producing state and faces major challenges in terms of availability of farm labor, wildfires, and water shortages. California is also at the center of global problems with logistics and supply chains. Robotics and AI technologies under development at the four CITRIS campuses can play a valuable role in addressing these challenges in ways that respect the health and importance of farm workers.

Technology and Society

CITRIS Policy Lab

The CITRIS Policy Lab supports interdisciplinary research, education and thought leadership to address core questions regarding the role of formal and informal regulation in promoting technological innovation and amplifying its positive effects on society.

Areas of interest include:

- Platform governance
- Responsible AI
- Digital inclusion
- Environmental sustainability and disaster risk reduction
- Blockchain and distributed ledgers

The Policy Lab also supports innovative methods of translating research results and offering new tools to researchers, practitioners and the general public. These may include policy briefs, white papers, playbooks, and op-eds or new software platforms for computational modeling, methodologies for integrating new workflows for data-intensive science, and data visualization tools.

Priority projects include:

- UC systemwide guidance on responsible AI (UC AI council) and digital inclusion (UC Broadband Working Group)
- Feedback to California Legislature and Congress on emerging tech policy issues
- Consultation with California agencies regarding implementation of emerging technology tools and platforms
- Technology and policy strategies to support responsible platform governance through Our Better Web, a collaboration with leaders from the UC Berkeley schools of information, journalism, law, and public policy and the Division of Computing, Data Science, and Society
- Responsible AI guidance through research, feedback on legislation and regulation, and student mentoring through the AI Policy Hub

Strategic goals for the next three to five years:

- Strengthen support of CITRIS initiatives' policy-related work through participation in multicampus research projects (Labor and Automation in California Agriculture) and working groups (Aviation)
- Continue to strengthen the role of CITRIS as a resource for UC systemwide guidance on tech policy-related issues (e.g., AI, blockchain, broadband)

- Support interdisciplinary research collaborations on effects of emerging technologies, including investigating the role of formal and informal regulation in promoting innovation and amplifying its positive effects on society
- Convene thought leaders for policy discussions and consultation leading to white papers and policy recommendations to university leaders and elected officials
- Secure extramural funding to support interdisciplinary research, workshops, and symposia

EDGE in Tech Initiative

The Expanding Diversity and Gender Equity in Tech (EDGE in Tech) Initiative at the University of California is committed to addressing the challenges faced by women and other under-included identities in engineering and computer science fields by serving as a trusted resource that integrates research with action.

Areas of interest include:

- Women in tech
- Diversity in tech
- Mentorship
- Inclusive leadership
- Future of work
- Equitable workplaces

Priority projects include:

- Annual symposium
- Biannual leadership roundtables
- Grant proposals to support initiative
- Student research into participation, persistence and advancement in science, technology, engineering and math (STEM)
- UC systemwide committee to improve DEI in innovation and entrepreneurship

Strategic goals for the next three to five years:

- Create slate of events for students, staff, executives and the public to promote gender diversity and inclusion and offer tools to advance this goal
- Support research into inequities in the tech sector and technology roles more broadly
- Build professional networks for late-stage graduate students, postdoctoral researchers and early-career alumnae to bolster their chances for professional success over the long term
- Raise funds to make EDGE in Tech at UC sustainable, to support appropriate staffing for research, communication and events

Campuses

UC Berkeley — Headquarters

UC Berkeley retains its standing as the No. 1 public university in the world. Over 45,000 students attend classes in 14 colleges and schools, offering 350 degree programs. UC Berkeley's historic place at the forefront of scientific and academic research and social movements fuels a drive to constantly push the boundaries of knowledge in research and scholarship, as well as in pedagogy and instructional technology.

On the UC Berkeley campus, CITRIS is located in Sutardja Dai Hall (SDH). Specially designed to house CITRIS, the building contains 141,000 square feet of laboratory space for collaborative research, a tech museum, faculty offices, the 149-seat Banatao Auditorium, conference rooms on each floor, co-working space, modern classrooms and a cafe.

SDH also houses the CITRIS Invention Lab, the first tech maker space on campus, founded in 2012. The Berkeley Marvell Nanofabrication Laboratory at CITRIS occupies a two-story, 15,000-square-foot wing where academic and industry researchers develop prototypes for new biosensors, photonics devices, and other micro- and nanoelectromechanical system (MEMS/NEMS) sensors. SDH is equipped with hundreds of sensors and sophisticated systems for building management that form a living laboratory on campus for energy research and proof-of-concept demonstrations.

SDH is also home to new and emerging centers such as the Berkeley Institute for Data Science (BIDS), the Center for Long-Term Cybersecurity (CLTC), and the Kavli Center for Ethics, Science and the Public. As a premier UC Berkeley event space, SDH has hosted numerous public-facing events including the DataEDGE conference, the EDGE in Tech annual symposium, and the College of Engineering's View from the Top lecture series.

Valued campus partnerships include the College of Engineering; Division of Computing, Data Science, and Society (CDSS); Goldman School of Public Policy; Human Rights Center at the School of Law; Office of the Vice Chancellor for Research; Lawrence Hall of Science; School of Information; and many more.

UC Davis and UC Davis Health

UC Davis is renowned for cross-disciplinary research and teaching that draw upon 100 academic majors; 87 graduate programs; and professional schools in business, education, law, medicine, nursing and veterinary medicine. The campus connects the greater Sacramento region with the Bay Area, the Delta and Sierra, and the Central Valley. CITRIS at

UC Davis brings expertise in engineering, nanoscience, law, agriculture and medicine to bear on complex challenges related to food, health, the environment and society.

Areas of interest include:

- Student engagement and mentorship in the areas of data science and STEM education (both for university and K-12 students)
- Smart agriculture
- Visual thinking (real-world applications of virtual reality and augmented reality)
- Aviation and uncrewed aircraft system (UAS) and drone research applications
- Prototyping equipment in the Engineering Student Design Center (ESDC) opening January 2023
- Continued Tech for Social Good student competition program
- Continuation of the summer Drone Academy with outreach roadshow to area high schools (pending new donor funding)

Priority projects include:

- The Engineering Student Startup Center, now a joint CITRIS operation, offers a maker space for undergraduate student innovations, primarily for student-led projects under the umbrella of the Tech for Social Good Program. With the planned renovation of the engineering building, this center will expand into an enhanced facility as part of the student design maker space.
    - The new Student Design Center opening in winter 2023 will include CITRIS equipment such as metrology 3D scanners and several Haas computer numerical control (CNC) mills for prototyping.
    - A planned visual thinking laboratory within the Student Startup Center will provide an environment to spark imaginations through visual experiences. Imagination plays a key role in innovation and problem-solving, yet methods of enhancing imagination are hard to teach in a typical classroom environment. A laboratory setting enables students to interact with devices, including virtual reality (VR) and augmented reality (AR), to stimulate visual thinking abilities.
- Seed funds in the areas of sustainable food production with indoor vertical farming systems. This is a growing area with an anticipated global market of $10 billion by 2026. Significant research will be necessary to improve energy efficiency, environmental control and plant health monitoring in indoor environments.

Strategic goals for the next three to five years:

- Establish strong ties with the administrators, teachers and students of multiple K-12 school districts and community colleges to strengthen the pipeline in STEM fields by pursuing mentoring and training programs, workshops, field trips, and competitions in aviation, data, information sciences and other STEM areas.

- Address the grand challenge in agriculture — how to use technology to increase the production of food and renewable energy in the face of a changing climate — by participating in the UC Davis Smart Farm initiative, under development by the College of Engineering and the College of Agricultural and Environmental Sciences. CITRIS at UC Davis will play a major role in this initiative and is already engaging with its leaders to develop standard uncrewed aerial vehicle (UAV) test and flight authorizations through the Federal Aviation Administration (FAA) community-based program, slated for release in 2023.This program will allow UC Davis researchers to design, build, test and fly UAVs for expanded applications in agriculture, smart farming, aerial data collection and state disaster response, among others. The Davis Drone Lab, part of the CITRIS Aviation initiative, currently supports the UAV STEM outreach activities on campus and at high schools in the area.
- Secure federal funding to support a new center on sustainable food production with indoor vertical farming systems that will include training opportunities for graduate students and postdoctoral researchers across CITRIS in various engineering areas of AI, sustainability and sensor networks that will be deployed as health and fitness trackers for plants to provide early identification of stresses, using these tools of precision agriculture.
- Establish a Clinical Innovation Center to develop, test and validate digital innovations to improve health care. At the medical campus in downtown Sacramento, UC Davis Health (UCDH) offers all the resources of major university research and teaching medical center, including a medical school, nursing school and 627-bed acute care teaching hospital, along with a multitude of institutes and labs that provide extensive facilities and programmatic resources for CITRIS programs and research.
- Actively promote the Center for Nano-MicroManufacturing (CNM2) among the CITRIS-connected labs at UC Davis. CNM2 provides the UC Davis campus community with a full spectrum of state-of-the-art micro-nano fabrication equipment, processes, and services. UC Davis invested $20 million to renovate the facility in the last five years. Two students have been accepted into the Workforce Innovation Program to work in this lab in summer 2022.
- Work with university executives to develop strategies for integrating CITRIS activities into the vision of Aggie Square, a new 25-acre research and innovation hub in downtown Sacramento. Envisioned and launched by Chancellor Gary May in 2018, the development will include a substantial technology incubators and accelerators for medical device development and digital health innovations along with housing, retail and office space.

UC Merced

As the first American research university of the 21st century, UC Merced serves as a major base of advanced research, a model of sustainable design and construction, and an economic growth engine for the San Joaquin Valley.

Given the expertise of the campus and its location, the foci of tech research has centered on agricultural technology which has yielded a new UC Merced Experimental Smart Farm facility; health and public health for the unique population needs regionally and large-scale; human and computer interaction technologies for seniors and visually impaired; and sustainability and water resources and information management, which has led to considerable investment by the state in understanding more about our water management. With researchers across all three UC Merced schools, partner programs include the Innovation + Design Hub, Innovate to Grow, the Health Sciences Research Institute and Sierra Nevada Research Institute, as well as collaborations with UC Agriculture and Natural Resources and Fresno State University. Potential industry partners include companies working in IoT, AI, geospatial analytics and remote sensing, and agricultural technology.

Supported by a CITRIS Seed Award, UC Merced responded to the COVID-19 pandemic by building a database to track wastewater incidences of COVID-19. Faculty are also pursuing cognitive constraints under emergencies, identifying tree mortality due to fire and assessing water security risk.

Home to the UC Center of Excellence on Unmanned Aircraft System Safety, UC Merced is a leader in UAV/UAS research and outreach. A CITRIS faculty member leads the Mechatronics, Embedded Systems and Automation (MESA) Lab, a state-of-the-art drone research and education facility. CITRIS Aviation specializes in gathering scientific data using UAVs, with the goal of developing practical solutions in the fields of agriculture and landscape ecology, as well as promoting the use and understanding of aerial data collection in the community. The program conducts mapping flights for various university research projects and builds upon campus facilities and resources by offering research partnerships to industry and providing UAS instruction to the campus, partners, and the public.

CITRIS at UC Merced also supports the next generation of prospective students through community outreach to middle schools, high schools, and local community colleges, with a focus on programs in agriculture and robotics.

Areas of interest include:

- Food-energy-water systems
- Aviation and remote sensing
- Wildfire information systems
- Healthtech for improved well-being, regionally and for specialized populations
- Climate resilient food systems, including electrification of agricultural vehicles
- Next-generation student outreach focusing on agriculture and robotics and drones
- Tech career prep for the next generation of water, climate change and STEM undergraduates

Priority projects include:

- To be determined summer 2022

Strategic goals for the next three to five years:

- To be determined summer 2022

UC Santa Cruz and UC Santa Cruz Silicon Valley Campus

With its focus on engineering for social good, the Baskin School of Engineering at UC Santa Cruz is naturally aligned with the CITRIS mission, and as the closest UC to Silicon Valley — with a satellite campus in Santa Clara — UC Santa Cruz offers CITRIS a critical footprint in the heart of the world's tech capital to attract industrial partners and professionals.

CITRIS at UC Santa Cruz's research focus spans work across the computational media department and top-ranked games and playable media and serious games programs to cyber-physical systems, UAS or drones, and data science.

The newly launched CITRIS Initiative for Drone Education and Research (CIDER) is developing curriculum and programming to support the use of aerial drones and associated sensors in both student and faculty research across all disciplines. Through the Student Pilot Training Program, CIDER guides diverse cohorts of students to master the use of drone platforms, sensors and data analysis and help them obtain their Federal Aviation Administration (FAA) remote pilot certification. Students are then able to support faculty research using drones, pursue their own work and participate in paid piloting opportunities with campus and industry partners.

Current climate-focused research explores the design of new systems for environmental monitoring using drone technology — including wildfire mitigation and response, water resource analysis and automated plant health detection. CITRIS researchers are also exploring ways to increase the efficiency and sustainability of aquaculture, through research and an associated start-up, thus securing a key element in future food security and the health of our oceans.

In the area of Health, CITRIS at Santa Cruz is supporting research and associated faculty start-ups in several notable areas, including autonomous patient monitoring systems for applications that include mitigation of pressure injuries for bed-ridden patients; the development of robotic platforms for rapid, low-cost viral testing, including for COVID-19;

and the use of virtual reality for patient interventions, including with physical therapy.

Going forward, CITRIS at UC Santa Cruz aims to support new projects focused on the rapidly growing areas of drones and urban air mobility, including explorations of low-altitude airspace management solutions and meeting the needs of a new, diverse drone workforce. Capitalizing on UC Santa Cruz's Silicon Valley Campus and its Monterey Bay Engineering, Science and Technology (MBEST) Center will provide outstanding opportunities for engagement with industry partners and our many partner educational institutions in the region.

Areas of interest include:

- UAV and UAS applications, technologies and systems
- Cyber-physical systems and networks
- Data science for social good
- Serious games and playable media
- Applications of and technologies for virtual reality and augmented reality
- Advanced sensor systems for health and environmental applications

Priority projects include:

- Developing climate resiliency research through 2022 Campus Seed Funding grants
- Through a planning grant from the James Irvine Foundation, CIDER is developing a program to support education and workforce training around drone technology for underrepresented communities in the Salinas and Pajaro Valley region
- Exploring the development of a publicly-owned system to help manage low-altitude airspace for the rapidly growing drone and urban air mobility use in partnership with local and regional stakeholders

Strategic goals for the next three to five years:

- Develop curriculum and a certificate program to support increasing diversity in the drone industry and to facilitate and grow opportunities for multidisciplinary UAV research and education
- Focus efforts on program development and industry engagement to capitalize on the Silicon Valley Campus as a resource for all CITRIS campuses
- Support efforts around the development of the MBEST facility, including developing test beds for collaborative research in areas including aviation, agriculture, wildfire management and others
- Prioritize the development of programs and curriculum to increase diversity, equity and inclusion (DEI) across all areas of CITRIS programming and campus support

Labs and Programs

Berkeley Marvell NanoLab

The Berkeley Marvell Nanofabrication Laboratory provides a 15,000-square-foot Class 100/1000 cleanroom to support the nanofabrication technology research of more than 100 principal investigators and over 500 academic and industrial researchers. Recent accomplishments include:

- Released new general access Direct Laser Write lithography tool. Initial training was completed by 53 lab members representing 21 faculty and seven affiliate companies. There has been sustained use of the tool by almost all researchers trained. The tool quickly became one of the most popular lithography systems in the laboratory because it precludes the need to first fabricate a mask. The tool was purchased based upon the following cost share: $180,000 over two years from VCR, $180,000 match from NanoLab affiliate company fee generated discretionary fund, and $100,000 support from the Berkeley Emerging Technologies Research (BETR) Center.
- Installed a refurbished scanning electron microscope in SDH Room 133. Tool release scheduled for June 2022. SEM is a high demand capability of the NanoLab; this is the NanoLab's third SEM system and will immediately be used by researchers from a wide range of PIs.
- The NanoLab looks forward to restarting the Berkeley High School Young Women Intern Program. This program was on hold during summer 2020 and 2021 due to pandemic related public health restrictions.
- The Berkeley NanoLab Affiliate Program continues to provide significant financial support of the NanoLab operations. Lab access by CITRIS Foundry members is also welcome and encouraged, at a discounted rate.

Strategic goals for the next three to five years:

- **Update and add laboratory capabilities**: Due to the steadily increasing national investment in microelectronics research capabilities, there are several opportunities from national funding agencies (e.g., National Science Foundation, Defense Advanced Research Projects Agency, etc.) for NanoLab infrastructure upgrades. The NanoLab has been responsive to these calls and is presently navigating a major potential NSF award. Final notice of award is expected between June and August 2022; if funded, the project would start February 2023.
- **Lower barrier to entry to ensure ongoing widespread academic use**: A primarily virtual orientation program has been implemented to meet pandemic restrictions. This process has streamlined many aspects of new member access to the NanoLab. An enhanced online equipment training program has been developed. The average

time for a researcher to become qualified on equipment has decreased thanks to this effort. In April 2022, the NanoLab will release Mercury, its newest and completely revamped, in-house developed laboratory management system. This platform upgrade has been in development for more than two years and is expected to take the NanoLab operation through the remainder of the 2020s.

- **Diversify revenue sources to strengthen business model**: The NanoLab incurred significant debt during the extended period of pandemic-imposed business loss. While many campus units continued to receive their funding allocations during the pandemic, as a recharge operation, the NanoLab had a three-to-four month period with zero income and more than 12 months with reduced activity. A three-year debt recovery strategy has been developed and approved by campus; up to five years may be required for full recovery. Any campus debt clearing proposals are of great interest. The NanoLab is in the final review stage of a major NSF grant proposal; additional opportunities for extramural funding from agencies, companies or private donors are welcome. The NanoLab is recommending a Memorandum of Understanding be developed between CITRIS and the College of Engineering (COE) to better define the relationship between CITRIS, COE and the NanoLab and to commit ongoing matched support to the NanoLab from both CITRIS and COE.

CITRIS Foundry and Entrepreneurship

Founded in 2013, the CITRIS Foundry empowers entrepreneurial researchers from the University of California to build transformative deep tech inventions that will have a significant impact on the world. It leverages the resources and expertise inherent in both the local innovation ecosystem and the institution's global collaborations to support new ventures, social enterprises and tech transfer pathways.

The Foundry was active until the end of 2021 when the program was paused due to other CITRIS priorities and leadership turnover. A future vision for the Foundry will be developed in 2022.

Strategic goals for the next three to five years:

- To be determined

CITRIS Invention Lab

Opened in 2012 as the first tech maker space within the UC system, the CITRIS Invention Lab serves as an educational, research, and entrepreneurial resource. At its core the CITRIS Invention Lab cultivates faculty, student and community creativity by providing the knowledge, tools and expertise to rapidly design and prototype novel products, embedded sensing systems and integrated mobile devices.

Over the past year, the Invention Lab has:

- Relaunched support and access for regular in-person lab fabrication and prototyping activities through Makerpass system
- Fabricated more than 100 SnapFab user-submitted design jobs for research and courses such as Designing Emerging Technologies, Critical Practices and Designing Prosthetics
- Expanded number of student superusers to increase lab access, elevate student leadership roles and broaden diversity of culture, skills and disciplinary expertise represented within the lab
- Held weekly Tech+Design Workshops from sketching to electrical prototyping and soft robotics design
- Supported community outreach efforts such as Girls in Engineering, EDGE in Tech Athena Awards, Berkeley Engineering's Transfer Pre-Engineering Program (T-PREP), and local high schools and middle schools
- Supported development and tours for visitors from Nyenrode University (in the Netherlands), SWE OHP-Orientation Host Program (a unique event specifically for women and nonbinary students admitted to UC Berkeley's College of Engineering), Beale Air Force Base delegation, HARTING Group (CITRIS partner), UC Riverside's Bourns College of Engineering (donors to UC Riverside's maker space campaign), St. Ambrose University, a Cal INvent-sponsored group of 25 Peruvian and Colombian youth and parents, Google Research, Siemens Energy, Engineering 198 Transfer Link 2.0 students, and more
- Support for sustainability work with biodegradable electronics, mycelium and soft robotics
- CITRIS PI research support, such as the design and testing of an energy-producing underwater kite for collaboration with SRI International
- Foundry team support for KwikKart, Sunchem, SportVue and others
- Featured work at Lawrence Hall of Science in Pathways to Innovation film

Strategic goals for the next three to five years:

- Strengthen support of CITRIS initiatives that involve physical prototyping and design, targeting specific engagement with CITRIS Aviation, CITRIS Health and aerospace efforts. This includes supporting research, courses and student clubs.
- Support for prototyping with AI/ML and data, using edge and cloud-based services for ML integration into designs. Supporting efforts within CITRIS initiatives and CDSS.
- Secure extramural funding to support interdisciplinary research, new tooling, workshops and courses, including campus funding opportunities
- Secure AR/VR support with Oculus

- Lead a vision for the future role of academic maker spaces with new robotic and AI-based creative platforms and APIs to support exploratory research and creativity
- Broaden campus engagement to diversify student representation beyond COE including events and workshops that connect or are designed specifically for or with other campus units
- Develop summer lab revenue generating programming in partnership with CITRIS Workforce Innovation Program and Jacobs Maker Launchpad
- Develop shared usage of lab with prototyping courses to increase revenue and increase lab discovery and access

CITRIS Seed Funding Program

The CITRIS Seed Funding Program uses a competitive request for proposals (RFP) process to source and catalyze work on major unsolved challenges facing society. CITRIS Seed Awards facilitate the early scientific groundwork necessary to pursue substantial funding for further research or commercialization. Since 2008, this flagship program has supported more than 235 projects and 400 researchers from the University of California. This growing portfolio of work demonstrates CITRIS's vision in the form of "early bets" on critical technology application areas including climate change mitigation, energy infrastructure, digital health care, robotics, automation, technology policy and inclusive innovation. The program is agile and can respond to emerging needs, including a special RFP issued in 2020 for IT-enabled responses to the disruptive COVID-19 pandemic.

Interdisciplinary by design, the CITRIS Seed Funding Program incentivizes researchers to collaborate across dozens of disciplines including engineering, computer science, medicine, public policy and economics. Additionally, awards are made to faculty teams that span multiple UC campuses in order to leverage the unique strengths and assets of each location. More than 400 postdoctoral researchers and graduate and undergraduate students have also been engaged in this pioneering work to date. These targeted, proof-of-concept projects run for an average of 12 months and yield valuable datasets, frameworks, publications, functional prototypes and pilot deployments. Awardees have garnered an average four-time return on the original award through follow-on funding from state, federal, venture capital, philanthropic and corporate sources to further develop these novel solutions.

Strategic goals for the next three to five years:

- Engage with mission-aligned partners to identify strategic themes and funding sources for follow-on investments and future seed rounds, informed by emerging societal needs
- Explore opportunities to provide post-award support and pathways for successful projects in collaboration with academic, public sector and industry partners

- Build an accessible library of CITRIS Seed Award projects and outcomes to benefit the broader research community

Student Discovery

CITRIS Workforce Innovation Program

CITRIS has nurtured student innovators through a variety of experiential programs such as Tech for Social Good, CITRIS Foundry, CITRIS Invention Lab, Cal Energy Corps, CITRIS Seed Fund Program and Berkeley Marvell NanoLab internships. Leveraging that expertise, a five-year, $5 million CITRIS Workforce Innovation Program funded by the state of California was launched in 2022 and will enable CITRIS to further support:

- Accelerating careers in next-generation innovation
- Addressing grand challenges relevant to the state
- Translating research into validated proof-of-concept and beyond

The program will actively engage and recruit underrepresented populations to increase opportunities for all students to transition to meaningful work after graduation. Select undergraduates will participate in eight-week paid internships in areas of emerging IT innovation: aviation, climate resilience, digital health, robotics and semiconductors. Host organizations, including established companies, startups, nonprofit organizations, national labs, and academic labs and programs, will participate by including the students in their research activities and mentoring them for future success. The students will also receive co-curricular training through pre-placement workshops and weekly seminars to guide their professional development and expand their horizons for future opportunities.

Strategic goals for the next three to five years:

- Host a total of approximately 100 students per year
- Adopt a growth mindset for evaluating and adjusting the program as needed to meet goals of high-quality learning experiences for the students, excellent interns for the hosts, and diversifying the pool of trained talent for the tech sector in California
- Recruit increasing numbers of host organizations willing to employ the students during or after their internships

Cal Energy Corps Program

The Cal Energy Corps, led by the California Institute for Energy and Environment (CIEE) in partnership with the CITRIS Workforce Innovation Program, is an undergraduate summer internship program engaging top UC Berkeley undergraduate students in the design,

development and delivery of sustainable energy and climate solutions. All placements are challenging, full-time assignments with leading organizations in the private and public sector, enabling students to gain professional experience working on the technical solutions of social issues in a cohesive learning environment.

In the last two years, the program has adapted to supporting remote and hybrid work for students and hosts, as well as putting on symposia virtually. In addition, the number of internship offerings expanded to nearly double the number available in 2020.

Strategic goals for the next three to five years:

- Achieve greater integration and alignment with the CITRIS Workforce Innovation Program
- Grow student awareness of program via increased participation in campus promotional events

Precollegiate Programs

NexTech Robotics, a hands-on outreach program run by undergraduate engineering students at UC Merced with support from CITRIS, Siemens and AgAID: AI Institute for Transforming Workforce & Decision Support, uses robotics and coding to inspire STEM concepts to middle schoolers. FLY CITRIS, a new program from the team behind NexTech, launched in fall 2021 and is designed to bring together agricultural and technology interests through drones and aviation, connecting students with spatial thinking, mapping and planning missions to collect data and yield novel results.

¡Valle! Get Your Start in Tech!, sponsored by Google Research, aims to foster diversity by increasing the accessibility of research experiences, graduate school, and careers in STEM to all students at UC Merced. The program is open to communities that are typically less represented in the STEM field such as people of color, women, financially disadvantaged students, first-generation college students, and students with disabilities.

The San Joaquin Valley Food and Agriculture Cyberinformatics Tools and Science (FACTS) bridge program, a paid summer research program funded by a grant from the U.S. Department of Agriculture National Institute of Food and Agriculture, is designed to give first-year and transfer students an opportunity for research experience in ag-food-tech.

The Drone Academy on the UC Davis campus is open to ninth through 12th graders from underrepresented backgrounds to teach principles of aviation and engineering. The camp is supported by a grant from the FAA's ASSURE Center of Excellence and operated in partnership with the UC Davis Early Academy Outreach Program.

DroneCamp, a collaboration between UC Agriculture and Natural Resources IGIS, CITRIS at UC Santa Cruz, CIDER and CSU Monterey Bay, is a short course designed to provide training to participants with a wide range of skill levels on the application of drone technology in mobility, security, agriculture, forestry and environmental monitoring.

Sustainable Business Model

CITRIS receives annual operating funds from the UC Office of the President. To ensure long-term organizational stability, CITRIS is pursuing complementary sources of funding to support research programs and other activities. These include a Partnership Program of industrial and academic partners and affiliates, a development program to cultivate individual donor and foundation support, and an outside venture capital investment vehicle that would provide returns to CITRIS. Individual directors and staff also actively seek underwriting for their programs and positions through extramural grants and contracts.

Industry Partnerships

The CITRIS Partnership program is a key element of the CITRIS research and innovation ecosystem, serving two important objectives: 1) to increase extramural financing for CITRIS research and innovation projects, and 2) to initiate collaborations that lead to positive change in the interest of society. As our partners integrate CITRIS ideas and innovations into the products and services they provide, this expands CITRIS's impact on the broader society in California, the U.S. and the world.

Exciting projects with our partners include:

- Siemens: enhanced robotic dexterity
- Siemens: programs at UC Merced, UC Davis and UC Santa Cruz tailored to support experiential STEM education for underserved communities
- Komatsu: autonomous operation of heavy vehicles
- Kajima: remote monitoring of infrastructure (dams)
- Enel: innovations in energy markets and battery technologies, remote monitoring of infrastructure (wind turbines)
- Lam Research: safer operation of microelectronics cleanrooms during and after the pandemic
- Facebook (Meta): innovative rapid testing for pathogens
- Microsoft: ethics and inclusivity for AI

Strategic goals for the next three to five years:

- Increase number of partners by two additional partnerships per year
- Sustain existing partnerships and support for more than one projects or initiatives (multi-anchor) where possible. For example, Komatsu, Siemens and Kajima support multiple research projects, while Lam Research and Facebook (Meta) are supporting both research and sponsoring EDGE in Tech Symposium.
- Explore ways to scale up the program, e.g., through an aviation consortium
- Develop additional focus on engaging early-career faculty with fundable projects
- Hold two curated roundtables with industry partners and prospects to communicate research achievements, generate dialog with faculty and seed new partnerships
- Explore new synergies, e.g., with philanthropic giving through corporate foundations

Development

CITRIS works with the fundraising community at UC Berkeley and other campuses to explore partnerships with major donors for annual giving, designated major gifts, and eventually, endowment funds. CITRIS welcomed a new development director in May 2021 to build a program and lead a team focused on individual donor and foundation support, as well as donor base expansion. This first year's focus has been on the following:

- Cultivating and stewarding a significant anonymous donor
- Identifying high-potential donor prospects whose interests match CITRIS's expertise
- Building strategic relationships with fundraising colleagues at multiple units on the UC Berkeley campus
- Building an infrastructure for an individual giving program
- Laying the groundwork for expanding the donor base and building the donor pipeline
- Exploring foundation support for EcoBlock, digital authoritarianism research and AI tech policy

Priority projects include:

- Partner with CITRIS research initiatives and programs to identify opportunities for engaging, cultivating and soliciting individual and foundation funders. Examples include:
    - Collaboration with CITRIS Health and CITRIS Climate to develop plan for private support of a new healthy aging community

    - Seeking philanthropic support for projects on the digital transformation of wildfire
    - Leveraging the CITRIS Workforce Innovation Program to cultivate high-potential donors and gain access to their networks
- Partner with fundraising teams at UC Berkeley (and across the four CITRIS campuses, as staffing permits) to share donor engagement opportunities and identify major gift prospects
- Partner with CITRIS leaders to create a more efficient process and platform for identifying CITRIS-wide giving opportunities at various levels

Strategic goals for the next three to five years:

- Continue to cultivate and steward major donors
- Identify and cultivate high-capacity donor prospects with interests in CITRIS's areas of activity and expertise
- EcoBlock: Work with city of Oakland to increase support from foundations
- Seek and secure foundation support for CITRIS projects and initiatives, as team resources allow
- Identify a fundraising champion to serve on the CITRIS advisory board
- Launch a giving circle to encourage gifts at certain levels, starting with $1,000 (aligns with UC Berkeley's Charter Hill Giving Society)
- Expand development team by one full-time employee (FTE) within the next year and by one more FTE within the next two to three years to create a sustainable model of success

Outreach

Public Programs and Events

Through its public offerings, CITRIS aims to foster a sense of intellectual community and encourage participation among our four campuses and broader technological community. Many CITRIS events have become virtualized and remain open to the public to meet the challenges of the COVID-19 pandemic, including weekly Research Exchange presentations during the semester, the annual CITRIS Day showcase and EDGE in Tech symposium, conferences and seminars, and a multitude of demo days and product showcases, along with offerings from each initiative, program and CITRIS campus.

Communications

The communications team tells the CITRIS story to bring visibility to its mission and highlight its achievements, visionary research and vibrant community through news

features, newsletters, email campaigns, web and social media content, multimedia storytelling, messaging and brand. The team also supports the promotion of flagship programs, conferences, speakers series and workshops.

Future plans include robust media outreach and strategic use of digital channels to deepen engagement with researchers, students, industry partners and donors through tailored content.

CITRIS Tech Museum

Located on the main floor of Sutardja Dai Hall at UC Berkeley, the CITRIS Tech Museum features projects and research from the CITRIS community including prototypes, hands-on displays and interactive demos. Visitors range from industrial partners, elected officials, student groups, prospective students and their families, filmmakers, media and more.

Operations and Administration

The operations and administrative staff on each of the campuses focus on two primary goals:

- **Public engagement** through facilitating lecture series and collaborating on events and conferences from inception to conclusion
- **Research support** through the facilitation of both logistics and financial management of research-related projects. These projects involve all CITRIS campuses and support student engagement as well as PI-directed research.

Conclusion

After two decades of service to the University of California and the state more broadly, CITRIS can take pride in the innovations its researchers have contributed to industry, startups it has nurtured, students it has inspired, advancements it has made toward a more inclusive economy, and policies it has shaped to safeguard positive effects of new technology while mitigating possible harms. The institute is well positioned to facilitate groundbreaking IT solutions to meet formidable global challenges on the horizon.

CITRIS is grateful for the opportunity provided by UC and the state to harness the interdisciplinary intellectual leadership on the four campuses to create a vibrant future for California and beyond.