

BOB

Supporting Innovation Through Corporate Collaboration



The relationship between Boeing and Caltech dates back to February 26, 1932, when Boeing began testing at Caltech's GALCIT aeronautics wind tunnel. This decades-long relationship became a formal, strategic partnership in 2004 that began with a focus on "systems integration technologies" and has since branched out to several other technologies, including hypervelocity, thermal ignition hazards, autonomous systems, and quantum nanophotonics.

Over the years, Boeing has worked with Caltech's Explosion Dynamics Laboratory to research fuel ignition safety. This led to the development of novel certification methods for the Boeing 787 program, and revised industry standards and design considerations for future aircraft such as the Boeing 777X. Caltech's partnership with Boeing has produced numerous patents and scientific manuscripts, and Boeing has licensed some of the resulting technology to further develop it for large-scale use. Boeing continues its collaboration with Caltech, funding multiple research projects and increasing interactions campus-wide with students, faculty and post-docs, including several annual undergraduate and graduate scholarships. As a result of the close collaboration and relationships developed through Boeing's activity on campus, many Caltech graduates have gone on to work at Boeing.

New Partnerships Towards Improving Sustainability

With two new partnerships in renewable energy and green chemistry, Caltech scientists and engineers remain at the center of building a sustainable future.

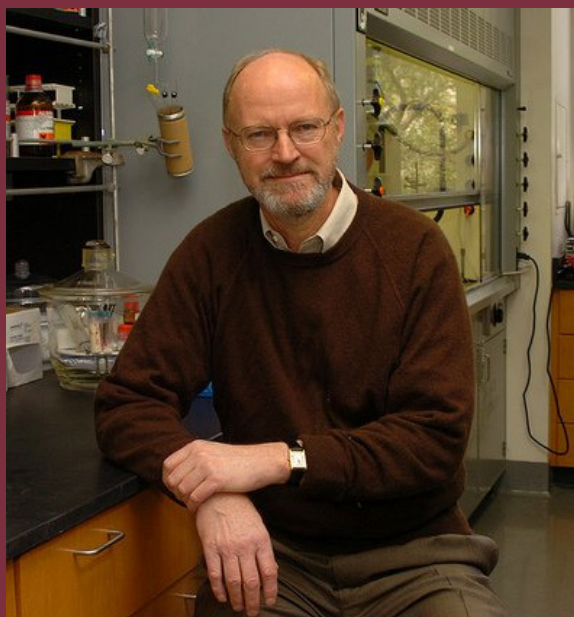
In a boost to wind power efficiency, engineers have developed a new control algorithm for wind farms which forces individual wind turbines to stop acting only in their own interest. Normally, individual turbines maximize their own access to wind by facing directly into it; now, the algorithm prompts them to adjust their orientation to maximize the wind farm's overall production.

The algorithm was developed in the laboratory of Caltech's John O. Dabiri (MS '03, PhD '05), the Centennial Professor of Aeronautics and Mechanical Engineering. A groundbreaking, three-continent agreement was created to enable real-world testing of the algorithm at a power-generating farm operated by ReNew Power in India. Using turbines designed by Siemens Gamesa Renewable Energy Innovation & Technology in Spain, the one-year test showed that by simply tweaking the orientation of the turbines the energy output of the farm increased between 1 and 3 percent. This demonstrates the potential for an immediate, no-cost improvement in existing wind farms and may enable future wind farms to be constructed in tighter quarters, thus squeezing more power out of less real estate.

In the Division of Chemistry and Chemical Engineering, Caltech has formed a new partnership in green chemistry. Many of the building blocks of modern life are produced using high temperature and pressure processes, which are some of the most challenging to decarbonize. With the support of Seattle-based Orca Sciences, Karthish Manthiram, Professor of Chemical Engineering and Chemistry and William H. Hurt Scholar, will continue his work to develop low carbon alternatives to these key processes. His lab is developing new chemical pathways, which will enable carbon dioxide, nitrogen, and water to be converted into a wide range of chemicals and materials using electricity. As a result of his work, the chemical industry could eventually be powered by renewable energy and potentially even become carbon negative.



Honoring Professor Robert H. Grubbs



Robert H. Grubbs, the Victor and Elizabeth Atkins Professor of Chemistry, passed away on December 19, 2021. Professor Grubbs, known by all simply as “Bob,” won the Nobel Prize in Chemistry in 2005 for the development of olefin metathesis catalysts that perform exchange reactions for carbon-carbon double bonds. In the Caltech News reflection on Bob’s life, Peter Dervan, Bren Professor of Chemistry, Emeritus, compared Bob to the great innovators of all time: “like Ben Franklin, Bob was drawn to ‘useful knowledge’ and was very much driven by practical inventions that would be impactful.” Indeed, many of Bob’s inventions have benefited us all. His impact on the scientific community was immense in polymer science and organometallics; and his impact on everyday lives outside of the scientific community was no less, with contributions ranging from medical science innovation to materials insulating pipelines for oil and gas.

To this day, Bob remains one of the most prolific Caltech inventors and is named on over 200 US patents, which led him to be a co-founder of numerous startup companies that licensed intellectual property from Caltech, including Materia—now a subsidiary of ExxonMobil Chemical Corp.—RxSight, Inc., Applaud Medical, Inc., polySpectra, Inc., and Cypris Materials, Inc. These companies produced innovations such as FDA-approved adjustable intraocular lenses for vision correction after cataract surgery, catalysts used to make Hepatitis C therapeutics, and thermal insulation for subsea pipelines.

In the last few years, Bob’s entrepreneurial activities peaked. In 2021 alone, he co-founded three startup companies. He was a 2021 co-recipient of a Rothenberg Innovation Initiative (RI2) Award for medical polymers that undergo remotely actuated shape change for surgical applications and a 2020 Merkin Translational Research Grant for spray-on antiviral coatings. He also saw two companies that he had co-founded years ago reach successful exits: first with the initial public offering of RxSight, Inc. in the summer of 2021, and then with the acquisition of Materia, Inc. by ExxonMobil Chemical Company in the fall of 2021.

However, Bob not only prolifically generated his own ideas but also fostered environments of innovation for those around him. He pioneered a series of informal brainstorming symposia with Caltech scientists and UCSF physicians, aiming to bridge gaps between clinical medicine and scientific innovation. Among the many concepts born during these symposia, one outstanding idea led to the founding of Applaud Medical, a company which uses ultrasound to non-invasively break up kidney stones. These symposia will continue in his name as the Caltech-UCSF Bob Grubbs Medical Innovation Symposia.

Bob’s entrepreneurial spirit never waned, and he learned as much from ideas that succeeded as he did from those that did not. In his Caltech office, Bob could often be found sitting in a rocking chair next to a coffee table with inventions and polymer samples crowding its surface. He would happily describe both the successes and failures of these inventions to any visitor. There are few innovators worthy of a comparison to Ben Franklin, but in Bob, we have been fortunate to have had a modern-day Franklin in our community.

On the cover: Professor Bob Grubbs (right) in his Caltech Lab, circa 1980

The Caltech Seed Fund

The Caltech Seed Fund invests in startups based on all areas of technology from Caltech and JPL. The investments follow research where strong commercialization opportunities exist. Current investments include:



Barrier Biosciences

Barrier Biosciences is a platform therapeutics discovery company founded

on technology from the Caltech lab of David Van Valen, Assistant Professor of Biology and Biological Engineering and Heritage Medical Research Institute Investigator. The company is utilizing artificial intelligence, machine learning, and spatial biology to create new therapeutics. Barrier Biosciences launched with CEO Ajay Kshatriya after raising seed funding from the Caltech Seed Fund, Wilson Hill Ventures, and other institutional investors.



Bohr Quantum

Bohr Quantum Technology is a quantum networking company founded on technology from the lab of Maria Spiropulu, Caltech's Shang-Yi Ch'en Professor of Physics. The company is developing

hardware and software to enable a new quantum internet and long-distance telecommunications with picosecond timing, which will be available to both classic and quantum computers. Bohr Quantum Technology launched with CEO Paul Dabbar and CSPO Conner Prochaska, with seed funding from the Caltech Seed Fund and Wilson Hill Ventures.



3Laws Robotics

3Laws Robotics is creating an autonomous robotics software solution founded on

technology from the Caltech lab of Aaron Ames, Caltech's Bren Professor of Mechanical and Civil Engineering and Control and Dynamical Systems. Aptly named after Asimov's "Three Laws of Robotics," the company is developing safety technology to add collision avoidance to autonomous robotic systems. Independent of a robot's operating system, the software is capable of working across multiple platforms by modifying control inputs to guarantee safe operation. 3Laws was co-founded and launched by Ames lab alumni, CEO Andrew Singletary (PhD '22) and CTO Thomas Gurriet (PhD '20) with seed funding from the Caltech Seed Fund, Wilson Hill Ventures, and Freeflow.



Port Therapeutics

Port Therapeutics is founded on technology from the Caltech lab of Mikhail Shap-

iro, Professor of Chemical Engineering and Howard Hughes Investigator. By combining breakthrough advances in biocircuit design and thermal targeting, Port is pioneering a new category of biomedicine that can deliver spatially controlled treatment to patients, to help doctors provide safe, precise, and potent therapies to improve patient care. In addition to Professor Shapiro, Port Therapeutics was cofounded by Caltech alumnus (PhD '09) and current Associate Professor at the Georgia Institute of Technology, Gabe Kwong, and Sangeeta Bhatia PhD, Professor and Director of the Marble Center for Cancer Nanomedicine at MIT. They launched operations in 2022 with seed funding from the Caltech Seed Fund, Wilson Hill Ventures, and other institutional investors.

Innovation.
Entrepreneurship.
Collaboration.

Our mission is to drive the transfer of scientific and engineering knowledge created by our researchers to maximize societal impact by developing partnerships with industry through the creation of new ventures, collaborations with corporations, and transfer of intellectual property while nurturing an entrepreneurial environment.

FY 2022:



133

Invention Disclosures
(campus only)



171

U.S. Patents Issued



14

Startup Companies



2,034

Active U.S. Patents



48

Licenses Granted
(including options)



47

Companies
Sponsoring
Research



55

Companies Giving Gifts



\$90.9M

Corporate Contracts & Gifts

Introducing: The Caltech Innovation Center

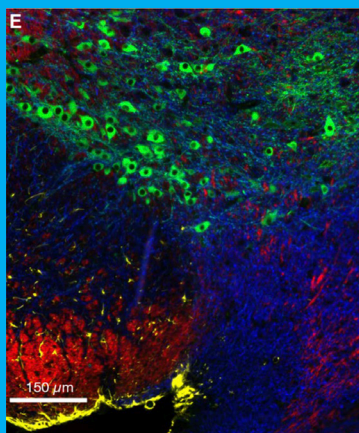
In early 2022, the Caltech Innovation Center (CIC) was inaugurated as part of the next step of Caltech's goal of establishing a dynamic campus startup ecosystem. In this system, the full cycle of research, innovation, and entrepreneurship is nurtured on-campus. Last year, Caltech launched the Caltech Seed Fund to aid faculty and students in furthering the innovation and research they are pursuing in the lab. Now, with the establishment of the CIC, Caltech can offer



not only funding but also competitively priced office space, keeping startups in close proximity to the first-class research, technologies, and professors on campus as well as the patenting and licensing expertise from OTTCP. The CIC will also be introducing programming, networking events, and mentorship opportunities for its startups and campus communities to enrich the growing entrepreneurship ecosystem at Caltech. In the future, the CIC will endeavor to offer wet labs and other specialized facilities for startups.

Ideas in the Lab

Rothenberg Innovation Initiative (RI2) 2022 Awards



High resolution RNA imaging from the Pierce Lab

A gift from Caltech Trustee James F. Rothenberg and his wife Anne launched the Caltech Innovation Initiative (CI2) in 2009 to provide essential seed funding for early-stage research that addresses pressing problems and could lead to marketable technologies that benefit society. Each RI2 award provides up to two years of support, with up to \$125,000 in funding per year, to help Caltech professors, students, and post-docs mature their research beyond the conceptual stage to the point that the innovations are attractive to outside investors for further development of the technologies. Bolstered by an additional \$15M gift in 2017 and renamed the Rothenberg Innovation Initiative (RI2), the program funded four new projects and five renewal projects in 2022.

Self-Assembling Viral Spike Nanoparticles as a Vaccine Platform Technology against SARS-CoV-2 Variants and Future Pandemic Coronaviruses (renewal)

Pamela Bjorkman, David Baltimore Professor of Biology and Bioengineering; Merkin Institute Professor; Executive Officer for Biology and Biological Engineering

Medical Polymers that Undergo Remotely Actuated Shape Change for Surgical Applications (renewal)

Chiara Daraio, G. Bradford Jones Professor of Mechanical Engineering and Applied Physics; Investigator, Heritage Medical Research Institute; Bob Grubbs, Victor and Elizabeth Atkins Professor of Chemistry

Cell Targeting with Synthetic Sense-and-Respond Living Circuits (renewal)

Michael Elowitz, Professor of Biology and Bioengineering; Investigator, Howard Hughes Medical Institute

Multi-Spectral Mid Infrared Image Sensors Using Volumetric Meta-Optics (renewal)

Andrei Faraon, Professor of Applied Physics and Electrical Engineering

Label-Free Identification of Amino Acids for Protein Sequencing (new)

Axel Scherer, Bernard Neches Professor of Electrical Engineering, Applied Physics and Physics; Merkin Institute Professor

Deep Learning-Enabled Optical Barcodes for Imaging Pooled CRISPR Libraries (renewal)

David Van Valen, Assistant Professor of Biology and Biological Engineering; Investigator, Heritage Medical Research Institute

Highly Tunable Lithium Tantalate On-Chip Entangled Photon Source (new)

Scott K. Cushing, Assistant Professor of Chemistry

Dynamic RNA Therapeutic Platform for Treating Diseased Cells Leaving Healthy Cells Untouched (new)

Niles A. Pierce, Professor of Applied and Computational Mathematics and Bioengineering; Executive Officer for Biology and Biological Engineering

Dynamic Correction of Presbyopia (new)

Azita Emami, Andrew and Peggy Cheng Professor of Electrical Engineering and Medical Engineering; Executive Officer for Electrical Engineering; Director, Center for Sensing to Intelligence