IX. RESEARCH AT UC SAN DIEGO

THE SIGNIFICANCE OF UNIVERSITY RESEARCH

UC San Diego research contributes to the local, regional, and State economy in several important ways. First, most research funding is sponsored by the Federal government, which means that most research funding flows into UC San Diego from a non-local source, University research is a significant generator of local jobs and income. It is, in effect, a major export industry, bringing hundreds of millions of dollars into San Diego County from sources outside the region. Second, many products of University research have commercial applications and provide the basis for the creation of new enterprises or the expansion of existing ones. Finally, the presence of a large academic research complex in the region serves as a magnet for corporate research and development centers and related enterprises that demand highly skilled University graduates.

Equally important, the research conducted at the numerous centers and institutions at UC San Diego helps to advance the knowledge and understanding of important issues in today's society and contributes to the development of technologies that improve the quality of life locally, nationally, and internationally. UC San Diego research focuses on a wide variety of important and timely issues such as healthcare, computer sciences, biotechnology, and engineering. Examples of some of the groundbreaking research conducted at the University are discussed in this chapter.

UNIVERSITY RESEARCH AS AN EXPORT INDUSTRY

Spending associated with sponsored research projects at UC San Diego during Fiscal Year 2006-07 totaled $714.3 million.[70] As Table 29 shows, the Federal government provided approximately 71.1 percent of the funding for the University's research expenditures during the year, with the Department of Health and Human Services, National Science Foundation, and Department of Defense accounting for the majority of federal funding sources.

[70] These impacts of UC San Diego research spending are included in the estimated economic impacts discussed in Chapter VI.

Table 29: Sources of Funding for UC San Diego Sponsored Research Expenditures FY 2007		
Source	Amount	Percent of Total
Federal Government		
Health and Human Services	$332,117,048	46.5%
National Science Foundation	$86,112,584	12.1%
Department of Defense	$44,666,950	6.3%
Department of Energy	$10,241,718	1.4%
NASA	$4,864,700	0.7%
All Other Federal Agencies	$29,766,379	4.2%
Subtotal	**$507,769,379**	**71.1%**
Non-Federal Government		
Foundations and Other Non-Profits	$112,196,675	15.7%
Industry	$72,244,095	10.1%
State, Local, and Foreign Governments	$22,095,795	3.1%
Subtotal	**$206,536,565**	**28.9%**
Total	**$714,305,944**	**100.0%**

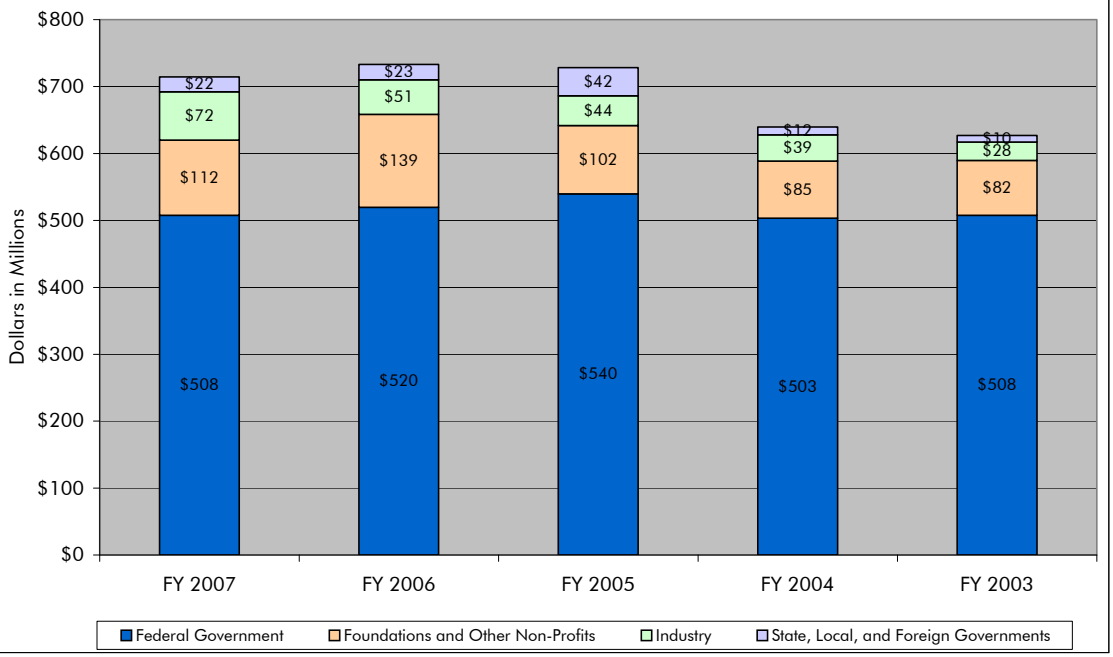
Sources: UC San Diego Office of Contract and Grant Administration Annual Financial Report 2007; and CBRE Consulting.
Notes: Total in Table 29 does not equal total in Table 30 because of approximately $1.788 million in Contracts and Grants Administration not accounted for in Table 29.

Figure 6 shows that the proportion of research funding from the Federal government has remained relatively constant over the past five fiscal years, ranging from a low of $503.3 million in FY 2004 to a high of $539.8 million in FY 2005. There was a slight drop of 2.5 percent in total research funding dollars between FY 2005-06 and FY 2006-07. While funding from foundations and non-profits decreased between FY 2005-06 and FY 2006-07 by approximately $26.82 million, funding from industry increased substantially from $51.45 million to $72.24 million. Industry grants have more than doubled since FY 2003-04.

Industry grants are particularly noteworthy because they represent the direct investment of commercial enterprises in the transfer of UC San Diego research into the marketplace. The primary mission of industry is the commercialization of marketable technologies for financial gain, and therefore industry is most supportive of relatively mature technologies on the brink of marketability. Earlier research for these technologies is usually funded by Federal or other agencies. Industry funding is then introduced if the technology is consistent with the current commercial interests of the company. Thus, the project performance expectations of the industrial sector are more focused and result-specific than other funding sources. The fact that industry funding increased so dramatically is a testament to the University's growing role as a generator of commercial products and applications that generate economic activity.

The influx of industry research funding is mostly attributable to a general increase in the amount of funding granted per award rather than an increase in the volume of awards. FY 2006-07 was marked by a 40.4 percent total increase (or $20.80 million) in funding dollars from industry partners, while the total number of industry research grants increased only 10.3 percent (from 788 to 869). A surge in the volume of very large industry research grants contributed to the trend; whereas in FY 2005-06 only one grant was awarded over $1.000 million, there were seven such grants awarded by the industrial sector during FY 2006-07.

Figure 6, UC San Diego Research Funding by Source, 2003-2007



Sources: UC San Diego Annual Financial Report 2007; and CBRE Consulting.

Funds from all research sponsors – particularly the Federal government and other non-local sponsorships – provide considerable economic value to the region, with the funds turning over multiple times through employment of personnel and purchase of goods, as reflected in the University-wide multipliers, discussed in Chapter VII, Direct, Indirect, and Induced Economic Impacts of UC San Diego. A primary added value is in the knowledge transfer within the San Diego region and the nation.

During Fiscal Year 2006-07, UC San Diego sponsored research funding was spent according to the distribution shown in Table 30.

Table 30: Sponsored Research Spending by UC San Diego Unit, FY 2007

Department	Amount	Percent of Total
School of Medicine	$274,832,000	38.4%
Campus-Wide Departments	$186,604,000	26.1%
UC San Diego Medical Center	$145,700,000	20.3%
Scripps Institution of Oceanography	$101,791,000	14.2%
Skaggs School of Pharmacy	$6,478,000	0.9%
Graduate School of International Relations and Pacific Studies	$631,000	0.1%
Rady School of Management	$57,000	0.0%
Total	**$716,093,000**	**100.0%**

Source: UC San Diego Annual Financial Report 2007.

Notes: Total in Table 30 is greater than total in Table 29 due to approximately $1.788 million that are spent on Contracts and Grants Administration expenses.

Not surprisingly, a significant amount of sponsored research dollars were spent by health and medical-related departments. As discussed in Chapter VI, University Purchasing and Payroll, the Medical Center was responsible for generating more Fiscal Year revenue than any other major source. At 38.4 percent and 20.3 percent, respectively, the School of Medicine and UC San Diego Medical Center were two of the largest beneficiaries of research sponsorship. Together these two departments contributed $420.5 million to the local economy in the form of health and medical research. Also related to the health sciences were the $101.8 million in research dollars spent by the Scripps Institution of Oceanography. Finally, $186.6 million in research spending were spread across the various campus departments while the University's newest professional school, Rady School of Management, was allocated $57,000 in research spending.

CONTRIBUTIONS OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH PROGRAMS AT UC SAN DIEGO

Research is one of the primary missions of the University of California and each campus has distinctive research foci. UC San Diego research programs span the fields of engineering, health and biological sciences, marine sciences, physics, and the social sciences. The programs implemented by these research centers contribute to the technical, social, and economic development of San Diego County and far beyond. In addition, UC San Diego research helps to inform policy-makers at the local, state, and national levels, contributing to standards and regulations that help protect public health and safety and promote general well-being. The following summaries highlight some of the key UC San Diego research projects, centers, and institutions and their contributions locally and elsewhere.

The Scripps Institution of Oceanography

The Scripps Institution of Oceanography is one of the oldest, largest, and most important centers for marine science research, graduate training, and public service in the world, and currently operates more than 300 research programs in 65 countries, on every continent, and in every ocean worldwide. Specific current research topics include The Oceans and Global Change, Earthquakes and Geology, Marine Biotechnology and Biomedicine, Marine Biodiversity and Conservation, Coastal Resources, and Technology and Support of Ocean and Atmospheric Research. UC San Diego scientists at Scripps Institution of Oceanography are pioneers in climate change science and the first to precisely measure greenhouse gases in the atmosphere. The Scripps Institution of Oceanography also operates Birch Aquarium in La Jolla as a public forum for its research findings. The aquarium's mission is to increase the public's understanding of the oceans, to interpret scientific endeavors, and to promote ocean conservation. Over 400,000 people visit Birch Aquarium every year.

Environmental conservation, alternative energy sources, and global climate change are among the world's fastest growing industries. By virtue of their expertise and prestige among marine science research institutions, scientists from the Scripps Institution of Oceanography ensure that San Diego is considered an international hub for climate change research. For example, four researchers from the Scripps Institution of Oceanography received a Joint Nobel Peace Prize in 2007 for their work as authors or reviewers of the Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC). The first component of this United Nations-sponsored report was released in February of 2007. Also of note is Project Atmospheric Brown Clouds (ABC), another United Nations-sponsored program based at the Scripps Institution of Oceanography that investigates the climate changes associated with the transcontinental travel of dust and pollution particles.

Although many current research endeavors have international implications, they are often implemented directly on San Diego or California soil. The activity associated with a research institution of international prominence is invaluable to the local San Diego knowledge base. Scripps Institution of Oceanography is currently collaborating with the City of San Diego, for example, to assess which areas of the city are most prone to flooding under a variety of climate change scenarios. Another current initiative is studying the effects of black carbon particles such as soot that travel from Asia across the Pacific Ocean to the West Coast. The research will ultimately assess how these pollutants might influence snow pack in the Sierra Nevada Mountains and in turn, the State of California's future water supply.

One of the many outreach programs for teachers, undergraduate students, and high school students that rely on research from the Scripps Institution of Oceanography is a new education initiative called Exploring the Science of our Oceans and Earth, led by Birch Aquarium. The program introduces K-12 teachers and students to new developments in scientific research at Scripps Institution of Oceanography through the "Planet Earth Express," a specially equipped van that transports environmental education programs and live marine animals to local schools.

California Institute for Telecommunications and Information Technology (Calit2)[71]

Calit2 provides an institutional home for cross-disciplinary projects developed by faculty at UC San Diego and UC Irvine. Calit2 focuses on building integrated systems built from newly emerging bioinformatics, telecommunication, information technology, and nanotechnology. Specific application research areas of these new digital infrastructures include: digitally-enabled medicine; education; environment and civil infrastructure; intelligent transportation; interfaces and software; materials and devices; network infrastructure; new media arts; and policy and society.

Like many research programs at UC San Diego, Calit2 plays an influential role in the local knowledge community by developing and deploying prototype infrastructure and devices to be used by other research departments in real-world contexts. For example, Calit2 strives to provide the main UC San Diego campus with cutting edge telecommunications concepts and infrastructure to promote research and education across multiple disciplines through effective communication.

These technologies are then used to study local and regional social issues such as: traffic congestion; environmental problems (water and air pollution, shortage of water, earthquakes, rising sea level, declining snow-pack); insufficient energy sources; emergency management; homeland security; healthcare; and the struggling entertainment industry.

Calit2 engages over 100 companies and has over 300 Federal grants associated with its faculty. Calit2 also reaches well beyond local boundaries to Greater California and the global marketplace. For example, the recent Calit2-hosted "U.S.-India Summit on Education, Research and Technology" triggered a series of high-level meetings that culminated in the "Calit2 for India" concept. The proposed public-private partnership for research and education would develop technologies for 700.0 million people in rural India. The Indian government has indicated its willingness to fund up to 49.0 percent of the research provided that Indian and U.S. corporations also sponsor the program.

[71] www.calit2.net

San Diego Supercomputer Center (SDSC)

SDSC provides data intensive cyberinfrastructure services to UC San Diego, national researchers, and industry partners. While most scientists and engineers work from a home research laboratory, academic department, or local environment, their research projects are meant to contribute to the national and/or global research community. When a project's technological needs outgrow the capabilities of its home environment, cyberinfrastructure provided by SDSC can extend the project's reach by providing scalable database, computational, storage, and other resources remotely. SDSC enables industry partners with access to these resources and collaborations in technology research and development, extending the impact of research methodologies in solving parallel commercial problems.[72]

Aside from its role as a data center for the University's core research undertakings, SDSC's Education Group implements outreach programs such as TeacherTECH. This award-winning program helps local San Diego educators bring new technology tools and technology-enabled science concepts into K-12 curriculum. Participating teachers learn about topics ranging from biodiversity in California to DNA extraction to 3-dimensional visualization in geology. They are also introduced to the latest technological advances – smart boards, podcasting, and iMovies for example – that can be applied to their own classroom settings. In 2007, TeacherTECH drew over 1,400 teachers from over 150 schools, who in turn reach up to 200,000 local students annually.[73] Because of local success, the program is being adopted by other supercomputer centers in the TeraGrid, a national network of nine National Science Foundation centers (including SDSC) that form the world's largest distributed cyberinfrastructure for open scientific research.

Center for Magnetic Recording Research (CMRR)

The mission of the CMRR is to excel in research, education, and transfer of innovative ideas in the field of information storage technology and systems, particularly advanced data storage based on magnetic recording.

The CMRR program is a collaborative approach by an interdisciplinary group of researchers to develop significant advances in ultra-high density storage and ultra-high data rates, particularly for disk and tape recording systems. Research is conducted in collaboration with UC San Diego Physics, Engineering, and the Graduate School of International Relations and Pacific Studies (IR/PS). IR/PS complements the technology studies by examining the business aspects of the data storage industry, and also collaborates with the Information Storage Industry Center (ISIC). The ISIC was established in 1998 as an independent academic research program that collaborates with industry partners based on research conducted by the CMRR and, to some extent, IR/PS. The ISIC studies the management issues faced by all segments of the data storage industry and works directly with the producers and consumers of advanced storage systems to develop and conduct observation-based research projects that increase storage industry knowledge.[74]

[72] San Diego Supercomputer Center, www.sdsc.edu.
[73] UC San Diego Annual Financial Report, 2006-07, page 24.
[74] UC San Diego, International Relations and Pacific Studies (IR/PS).

Whitaker Institute of Biomedical Engineering (WIBE)

The Whitaker Institute of Biomedical Engineering (WIBE) aims to advance knowledge in biomedical engineering by promoting interdisciplinary research and training among engineering, biology, and medicine, with the ultimate goal of improving the health and quality of human life. This coordination between engineering and biomedical research allows the unique generation of quantitative research in the biomedical field, and leads to innovative investigative approaches. The WIBE enhances research in molecular and cellular bioengineering, molecular biomechanics, and targeted molecular delivery based on engineering principles. The overarching theme is integrative bioengineering, spanning the spectrum from molecular to organismal levels and integrating engineering and biomedical sciences.

The WIBE has identified "tissue engineering science" as a major research thrust, using the principles and methods of engineering and life sciences to understand the structural and functional relationships inherent in human tissues, then develop biological substitutes that restore, maintain, or improve tissue functions. WIBE research in body tissues is meant to prevent, diagnose, and treat diseases, conditions, and injuries on those tissues.

One example of the interdisciplinary nature of WIBE is the Project on Glucose Monitoring and Control. Its goal is to develop and evaluate new approaches, both natural and engineered, to achieve ideal blood glucose control and metabolic management in diabetes and related diseases. The Project serves as a forum for information exchange and works to develop new medication delivery approaches and evaluation of control strategies.

The WIBE facilitates academia-industry cooperation and holds regular research seminars, workshops, and symposia to promote information exchange, generate new ideas and projects, and foster interdisciplinary training of graduate students and postdoctoral fellows.

UC SAN DIEGO CENTERS FOR RESEARCH IN THE PUBLIC INTEREST

In addition to the research in cutting edge science and technology, UC San Diego hosts numerous other research centers that address issues of social importance. These centers, a sampling of which are discussed below, focus on a variety of topics including climate change, environmental conservation, international relations, social and economic policy, education, and arts and culture.

Graduate School of International Relations and Pacific Studies (IR/PS)

Collectively, the nations of the Pacific Rim include the largest population and economic centers and the largest concentration of natural resources and agriculture in the world. Guided by the premise that the 21st Century will be driven by the dynamics of these exploding societies and governments, IR/PS aims to mold the forces of economic growth, technological innovation, and environmental and security challenges into positive instruments of peace, prosperity, and democracy and to help build a Pacific community by creating ideas, training leaders and

providing networks. To that end, IR/PS operates a number of research centers and affiliated programs as follows:[75]

The **Center on Pacific Economies (CPE)** examines why countries in the Pacific region, the Americas, and Asia differ in their ability to maintain sustainable growth, financial stability, technological innovation, and economic equity. This center and its programs are contributing to San Diego's growing reputation as a leader in U.S. – Pacific international affairs.

The **Center for U.S.-Mexican Studies** supports research relevant to current policy issues between Mexico and the United States. San Diego is home to the most active border crossing between the United States and Mexico, and understanding the complexities of U.S.-Mexico relations, particularly as it relates to immigration, is a growing concern within the U.S. government. The Center for U.S.-Mexican Studies provides a local base from which to study this relationship.

A number of student-run organizations operating out of the IR/PS school at UC San Diego contribute directly to local industry through their research. **Strategic Community Consulting (SCC)** is a student-run organization that provides consulting services to nonprofit and public sector clients in San Diego. An ongoing project called "Coastkeepers," for example, rates the San Diego Board of Supervisors according to their voting record on a variety of environmental issues. A global market research group called **Export Access** promotes international trade for San Diego businesses. Local consulting projects include the expansion of San Diego International Airport and estimating the value of the military to the local economy. Finally, **The Environment Society** is an IR/PS student-run organization that facilitates discussions between students interested in the environment and local professionals working in this field.

Based on research conducted for the above programs and a host of others, IR/PS professors edit and write for a number of prominent research journals. Among them are the *Journal of the Japanese and International Economies,* the *Journal of East Asian Studies,* the *Journal of Environment & Development,* the *Journal of Financial Markets,* and the *Journal of International Policy Solutions*.

Throughout the academic year, students and researchers also contribute to the local economy through internships. San Diego employers hire the expertise of IR/PS students to research, market, and evaluate local programs at the San Diego Foundation, Tijuana Estuary, San Diego County Taxpayers Association, and Bainbridge Consulting, to name a few. IR/PS alumni continue to work and contribute to the local economy after graduation.

Institute on Global Conflict and Cooperation (IGCC)

The Institute on Global Conflict and Cooperation (IGCC) is a multi-campus research unit (MRU) serving all ten UC campuses and the Los Alamos and Lawrence Livermore National Laboratories. The institute is based at UC San Diego, and facilitates research and training related to the causes of international conflict and prevention or resolution of those issues. Through its many research programs, the IGCC provides opportunities for UC faculty and students to collaborate with government officials domestically and internationally, to establish effective international policy. Research programs include National Security Policy, International

[75] Information on the mission of UC San Diego's Graduate School of International Relations and Pacific Studies was provided directly by IR/PS personnel.

Environmental Policy, Public Policy and Nuclear Threats, Public Policy and Biological Threats, and Regional Relations. A few of these are discussed below.

The **International Environmental Policy** research initiative studies the economic effects of climate change and identifies how the environmental stresses of pollution and global warming may lead to international conflict. Through this research, the IGCC aims to promote cooperation between countries that share common environmental problems. Examples of shared environmental imperatives may be the establishment of joint management policies for marine resources in order to preserve fish habitats, or the restoration of basic agricultural, environmental, and health services following military conflict in war-torn areas like Afghanistan or Iraq.[76]

The program for **Public Policy and Nuclear Threats** was organized to train doctorate-level Public Policy and Nuclear Threats Fellows throughout the UC system to replace the aging population of international policymakers on this subject. The program is backed by a six-year, $3.100 million grant from the National Science Foundation. Researchers work closely with Los Alamos and Lawrence Livermore National Laboratories to understand the technical aspects of nuclear weapons and with the UC Washington D.C. office, which was established to promote the interaction between IGCC researchers and Washington policymakers.

The Center for Comparative Immigration Studies (CCIS)

A campus-wide research unit of UC San Diego established in 1999 as part of the Division of Social Sciences, CCIS conducts basic and policy-oriented research projects on international migration and refugee flows throughout the world. These studies seek to illuminate the U.S. immigration experience through systematic comparison with other countries of immigration, especially in Europe and the Asia-Pacific region. Each year, the Visiting Fellowship Program brings together a multidisciplinary, multinational community of researchers sharing these interests. Through the global network of research associates, the Publications program, and the Media Information program, the CCIS strives to disseminate the results of academic research to a broad array of users.[77]

CCIS is currently implementing two important research programs related to U.S.-Mexico immigration policy. The first study investigates the process of Mexican-American integration into the U.S. political system. The second initiative studies the consequences and effectiveness of United States immigration control measures enacted by the Federal government during the past ten years. Both research programs will provide important information for future immigration law reforms.

FROM THE LABORATORY TO THE MARKETPLACE

Research can lead to fortuitous inventions that the University can develop under U.S. patent law. The UC campus-wide patent policy encourages the practical application of research for public benefit, by nurturing the development and transfer of innovations from campus to the marketplace for the benefit of society at large. To this end, UC San Diego's Office of Technology Transfer and Intellectual Property Services (TechTIPS) assists in the disclosure and development of campus researchers' invention properties and encourages their further

[76] IGCC News*Wired* Annual Review, 2003-2004, page 9.
[77] www.ccis-ucsd.org

development through licensing or business start-ups. TechTIPS also coordinates with other agencies to promote research based on UC San Diego technologies. The University has an obligation to seek fair compensation for the use of public funds, and seeks contractual collaboration with companies that will foster the most active and rapid implementation of its technology. This may be with a national business or a local company.

The **William J. von Liebig Center** also provides support for UC San Diego research projects approaching commercialization. The von Liebig Center catalyzes the commercialization of early stage technologies specifically out of the Jacobs School of Engineering. In five years since its founding on campus in 2001, the von Liebig Center has funded 66 early-stage technologies with grants of up to $50,000. These projects have resulted in 19 licenses and helped to launch 15 start-up companies, which have attracted more than $71.00 million in subsequent capital from the private sector.[78]

By virtue of its historical performance, UC San Diego is established as one of the top UC campuses for the transfer of research into the marketplace. As of June 2006, UC San Diego held the largest invention portfolio of any UC campus with a total cumulative portfolio of approximately 1,750, followed by UC San Francisco with 1,330 and UCLA with 1,290. Total U.S. patents held by UC San Diego ranked third among UC campuses with 506 active patents.[79] During FY 2006-07, UC San Diego continued its research prominence among UC campuses. Faculty and staff disclosed 373 new inventions, 64 U.S. patents were added to the University's patent portfolio, and 85 license agreements were formulated.

License agreements generated by UC San Diego research translate into direct revenue for the University. Each license agreement grants access to a University invention provided that the licensee agrees to commercialize and further develop the invention. Typically the right to commercialize is granted in return for fee payments made to the University, including reimbursement of patent expenses and royalty payments when products reach the marketplace. During Fiscal Year 2005-06, new licenses from UC San Diego TechTIPS ranked number one among all UC campuses and generated $26.70 million. UC San Diego was also responsible for two of the University of California's top five revenue-generating inventions for that year.[80]

While the University's interest is for wide development of new technology, participation of the inventor in the product's development sometimes leads to private business activity. The commercialization of technologies developed by UC San Diego research yields significant economic benefits to the San Diego region, the State of California, and the nation. Since 2001, 67 new start-ups have formed using licensed UC San Diego technology. During Fiscal Year 2006-07, nine start-up businesses were formed including: App2You; GcFree, Inc.; ICSX, Inc.; La Jolla Medical Devices, Inc.; ProBio, LLC; SomTherapeutics, Inc.; Tinnitus Otosound Products; and Traversa Therapeutics, Inc. Examples of a few of these research achievements and their commercial applications follow.

---

[78] Information provided by Rex Graham, Communications Director for Jacobs School of Engineering, May 28 2008. The start-up companies that received assistance from the von Liebig Center were included in the analysis of start-up companies in Appendix C, Table 31 and Table 32.

[79] At the time of this report, information on UC system-wide technology transfer was not yet available for Fiscal Year 2006-07.

[80] UC Technology Transfer Annual Report 2006, page 10. At the time of this study, official information for Fiscal Year 2006-07 was not yet available.

Tinnitus Otosound Products

Tinnitus, a medical condition characterized by a ringing in the ears, occurs within the brain as a person loses their hearing. The auditory cortex of the brain seeks to compensate for the loss of hearing by generating more nerve activity, which causes the ringing. Three collaborating UC San Diego researchers theorized that generating external auditory stimuli to match the exact frequency of the sound in a patient's brain could mitigate the ringing within their brain. The result of their research is Customized Sound Therapy, which mitigates the ringing experienced by over 30 million Americans. Since the company was formed in 2003, Tinnitus Otosound Products has operated on roughly $550,000 in grants, refining its technology and conducting trials for the Food and Drug Administration so that the therapy may be classified as a medical treatment as opposed to only a mitigation device. If Tinnitus Otosound Products succeeds, UC San Diego will receive a royalty of approximately 5.0 percent of the company's revenue, which will go towards financing additional research.[81]

App2You

Seed funding from the Jacobs School of Engineering as well as collaboration from TechTIPS and the San Diego Supercomputer Center assisted in the 2006 incorporation of App2you, a start-up web application currently in testing stages. App2you builds database-driven web applications based on user-provided sketches that describe the page structure and the flow of information on the page in simple, non-technical terms. Sophisticated algorithms are applied to the back-end database design based on the options chosen by the user.[82] In this way, sophisticated web database applications may be easily created by users without web design experience. A variety of UC San Diego student groups are currently utilizing the application and providing feedback to the company.

Traversa Therapeutics, Inc.

RNA Interference (RNAi) is a recently discovered natural biological process whereby intervention blocks the body's production of disease-causing proteins. Since undesired proteins are the cause of most human disease, and proteins are produced by RNA, RNAi has enormous therapeutic potential. Delivery of the therapy is the one significant remaining problem to be solved before RNAi can achieve success as a drug class, potentially providing treatment for 60 percent of all human disease.

Traversa Therapeutics, Inc. was founded by researchers at the Howard Hughes Medical Institute at UC San Diego in mid-2006 and has secured worldwide exclusive licenses to intellectual property. The company engages in two core tasks: the discovery, development, and commercialization of an RNAi delivery platform that can be utilized by therapeutic companies to treat acute, chronic, and infectious human diseases; and the advancement of the company's own therapeutic programs for the specific treatment of Leukemia and Glioblastoma.

As discussed throughout this chapter, the research undertaken by UC San Diego students and faculty provide the local community with an on-going supply of positive economic impacts. First, the stream of research funding that originates from outside San Diego County supplies

[81] Information about Tinnitus Otosound Products originated from an article titled "The Route from Research to Start-Up" published by the New York Times on January 18, 2007.
[82] Jacobs School of Engineering, Pulse newsletter, spring 2007.

economic stimuli within the region. Furthermore, UC San Diego research projects generate innovative policies, technologies, and products that may be marketed commercially. Industry research grants have grown over the past five years in recognition that quality research undertaken by UC San Diego will result in future financial rewards. This trend is a testament to the fact that the various research institutions provide valuable knowledge that can be converted directly into financial gain. Finally, each research institution does its part to ensure that the global knowledge base profits from its findings, by implementing outreach programs, publishing scholarly journals, or making recommendations to government entities. These efforts ensure that the positive effects of UC San Diego research will continue for years to come.

QUANTIFYING THE ECONOMIC IMPACTS OF UC SAN DIEGO-AFFILIATED START-UP COMPANIES

Revenue and Job Contributions

The transfer of UC San Diego research, technology, and intellectual property into the marketplace provides direct and quantifiable economic impacts to the local, statewide, and national economies, most notably in the form of sales revenues and local employment opportunities. Multiple UC San Diego offices including TechTIPS and the Office of Alumni Relations track start-up companies that were founded by UC San Diego alumni or faculty. For the purposes of estimating the economic impacts of these companies – which would not have been possible without the direct involvement of UC San Diego – CBRE Consulting compiled a list of 193 companies based on the records of the various UC San Diego offices.[83]

Research was conducted regarding each of these companies to determine their location, industry, revenues, employment, and other relevant data. Because of the relatively volatile nature of most start-up companies, some of the companies on the UC San Diego-provided lists were found to have been acquired by other companies, had changed their name, or were no longer in business. Others are now located outside of the State of California and were not further researched for the purposes of this report.

A complete list of UC San Diego-affiliated start-up companies found to be operational in California is provided in Appendix C of this report.[84] Included in this list are data on 67 of the 193 companies that were provided by UC San Diego staff. The remaining 126 companies fall into one of the following categories:

- 87 companies for which no information was found. Note that the search was limited to the State of California. These companies are therefore assumed to have ceased operating or are now located outside of the state.

[83] UC San Diego personnel acknowledge that this list of companies is not comprehensive, but represents the most complete list of companies that is available at this time.

[84] Several of the companies included in Appendix C and discussed in this section are also mentioned in other areas of this report. Table 9, within Chapter IV "Research at UC San Diego," provides a sample of companies founded by UC San Diego alumni and faculty. Some of the companies shown in Table 9 have unknown sales revenues and employment. These companies are: AnalgesiX, Inc.; Aurora Biosciences; Clinical Micro Sensors; and CryoGen. Eilean Technologies is located in Las Vegas, NV so its economic contributions are excluded from this report. Data was unavailable for Celera Genomics, which was also mentioned in Chapter IV, and Tinnitus Otosound Products, which was mentioned in Chapter II, "Introduction."

- 33 companies with confirmed operations in California, but no detailed company information available from dependable sources; and

- 28 companies that were acquired by other companies. Note that these companies continue to contribute economically, but their impacts cannot be isolated by virtue of their incorporation into a larger company infrastructure.

The 67 companies shown in Appendix C had combined estimated 2007 annual revenues of approximately $10.239 billion and employment of 17,260.[85] Companies located in San Diego County accounted for 95.0 percent of employment in all 67 California companies. While not measured, these high levels of revenue and employment are strong indicators of local economic impacts, attributable to company expenditures on personnel (salaries and wages) and goods and services. In addition, they are helping to support the local real estate industry through their real estate operations.

Table 31: UC San Diego Start Up Companies Located in California, 2007

Industry Classification	Number of Companies	2007 Annual Sales	Total Employees
Communications and Electrical Equipment	5	$9,932,700,000	14,831
Health Care Services	2	$129,698,000	520
Drugs and Pharmaceutical Products	2	$49,100,000	169
Scientific Research Services	15	$46,293,000	554
Software and Computer Services	10	$26,975,000	213
Biological Products	2	$25,168,000	217
Consulting Services	6	$5,366,000	71
Medical and Optical Instruments	7	$8,100,000	78
Pharmaceutical Preparations	5	$5,672,000	455
Miscellaneous Retail	4	$3,845,000	60
Other	5	$2,719,000	33
Social Services	2	$2,260,000	56
Investment Services	1	$880,000	3
Aircraft Equipment	1	$83,000	1
Grand Total	**67**	**$10,238,859,000**	**17,261**

Sources: UC San Diego office of Alumni Relations, Tech TIPS; Dun & Bradstreet; company websites; and CBRE Consulting.

Notes: This table excludes start-up companies founded by UC San Diego faculty or alumni, that were subsequently acquired by other companies. Data for the Communications and Electrical Equipment category includes Qualcomm, which employs 12,800 people and had 2007 revenues of approximately $8.871 billion.

Table 31 sorts the 67 known California companies by industry. Revenues are greatest for the Communications and Electrical Equipment group because Qualcomm Inc. accounts for $8.871 billion in revenues, which comprises 89.3 percent of that group. In general, the table demonstrates UC San Diego's strength in transferring technological, life sciences, and research endeavors into the local marketplace.

[85] Note that Qualcomm, Inc. employed 12,800 people and had 2007 revenues of approximately $8.871 billion.

Direct, Indirect, and Induced Economic Impacts of Start-Up Companies Affiliated with UC San Diego

As discussed in Chapter VII, Direct, Indirect, and Induced Economic Impacts of UC San Diego, the indirect and induced economic impacts associated with direct output can be estimated using multipliers provided by the IMPLAN input-output model. Table 32 provides an estimate of the direct, indirect, and induced impacts associated with the 67 start-up companies listed in Appendix C.

Table 32: Summary 2007 Economic Impacts of Start up Companies Affiliated with UC San Diego (Non-Cumulative)

	City of San Diego	Other San Diego County	Other California	Total Statewide
Output				
Direct	$11,505,375,602	$897,699,677	$1,025,781,172	$13,428,856,450
Indirect/Induced	$11,115,403,220	$1,936,339,711	$2,806,259,394	$15,858,002,325
Total Output	$22,620,778,822	$2,834,039,388	$3,832,040,565	$29,286,858,775
Employment				
Direct	14,832	1,561	868	17,261
Indirect/Induced	70,264	27,834	14,208	112,306
Total Employment	85,096	29,395	15,076	129,567
Personal Income				
Direct	$1,880,707,513	$203,208,110	$502,942,767	$2,586,858,390
Indirect/Induced	$3,994,008,931	$533,520,087	$1,035,580,550	$5,563,109,568
Total Income	$5,874,716,443	$736,728,198	$1,538,523,317	$8,149,967,958

Sources: UC San Diego Tech TIPS and Office of Alumni Relations; Applied Economics; start-up company websites; Dun & Bradstreet; and CBRE Consulting.

In order to generate these estimates, each of the 67 start-up companies was assigned a set of multipliers based on its Standard Industry Classification (SIC) code. The multipliers assume that each company has spending, employment, and payroll characteristics that are "average" for its industry. For example, a pharmaceutical company was assigned multipliers that describe the pharmaceutical industry in general.

Each company's direct output was calculated based on its direct employment as shown in Appendix C. Direct output, in millions of dollars, is calculated by dividing a company's direct employment by its direct jobs multiplier. For example, a company with 30 direct employees and a direct jobs multiplier of 3.00 jobs per $1.000 million of output has total direct output of $10.00 million. All indirect and induced impacts were calculated based on the company's direct output, consistent with the methodology described in Chapter VII and Appendix C. The impacts are as follows:

- Total direct, indirect, and induced impacts in the State of California were $29.287 billion in spending, 129,600 jobs, and $8.150 billion in personal income generated.

- The vast majority of the impacts were realized in the City of San Diego: $22.621 billion, or 77.2 percent of spending; 85,100 or 65.7 percent of jobs; and $5.875 billion or 72.1 percent of all personal income generated within the state of California.

- Impacts outside of San Diego but within San Diego County were $2.834 billion in spending, 29,400 jobs, and $736.7 million in personal income generated.

- Finally, the impacts to other areas of California outside of San Diego County were $3.832 billion in spending, 15,100 jobs, and $1.539 billion in personal income generated.

These impacts are driven in a large part by the economic contributions of Qualcomm, Inc., undoubtedly the most economically significant contemporary company to have roots in UC San Diego. Within the City of San Diego, Qualcomm had total direct and indirect output of $21.544 billion, total employment impacts of 80,150 jobs, and contributed to $5.550 billion of direct, indirect and induced personal income generated within the City of San Diego.

The findings suggest that start-up companies based on UC San Diego technologies and innovations contribute an overwhelming share of their economic impacts to the local and regional San Diego economies. Moreover, the economic impacts are likely understated because of the limited amount of data available on these types of companies. The list of companies that found their roots in UC San Diego research is likely to be much longer than 193 names. Furthermore, start-up companies are relatively new by definition, so detailed information on their operations is relatively limited compared to more established companies.