

# Carnegie Mellon University

## Research Development Report

### Reporting Period:

July 1, 2013 – June 30, 2014

### Commercial Development of Research

Carnegie Mellon University (CMU) has an excellent reputation for technology transfer, particularly in life and health sciences. Table 1 shows total transactions in life and health sciences over the past ten fiscal years. Over the past decade, they have accounted for a fifth of CMU's invention disclosures, a quarter of patents received, and a third of start-up companies formed. Table 2 shows technology transfer activities per \$10M of sponsored research, which are standard metrics used by the Association of University Technology Managers (AUTM). For patent applications and for start-up company formation, CMU life and health sciences is approximately 50% more productive than the university as a whole. The fact that licensing activity for life sciences research is lower than overall is licensing overall can be attributed to generally greater insistence of licensee companies that life/health science intellectual property be patented. Table 2 also shows recent AUTM averages. CMU consistently compares favorably with other universities in technology transfer activities. Importantly, our commercialization of life and health sciences research through start-up company formation is especially strong, several multiples of the AUTM average.

**Table 1: CMU life & health sciences commercialization efforts in past ten fiscal years (FY05-14)**

<b>indicator</b>	<b>#</b>
invention disclosures	336
patent applications	302
patents received	74
licenses/options executed	49
start-up companies formed	32

**Table 2: Comparison of CMU commercialization performance metrics to recent AUTM averages**

	CMU life sciences (FY05-14)	CMU all research (FY04-13)	AUTM data (FY10)
<b>actions per \$10M of sponsored research</b>			
invention disclosures	6.71	6.17	
patent applications	6.03	4.19	
patents received	1.48	1.25	0.76
licenses/options executed	0.98	2.24	0.91
start-up companies formed	0.64	0.41	0.11

Carnegie Mellon’s technology commercialization efforts are spearheaded by our Center for Technology Transfer and Enterprise Creation (CTTEC), which serves all faculty, staff and students. The CTTEC proactively identifies new research discoveries, legally protects those research discoveries, connects inventors with potential licensees and investors and negotiates licensing agreements to transfer those research discoveries to commercial entities.

Our policies and practices for technology transfer and intellectual property are straightforward and inventor-friendly. For example:

- The CTTEC must assess new discoveries and reach a decision whether to pursue or not pursue a patent within 120 working days from submission of the invention disclosure.
- In the event that the university decides not to pursue a patent, the ownership rights may revert to the faculty inventor (provided any government source of funding has not opted to elect title), though the CTTEC will still provide the inventors with commercialization assistance if requested.
- Equity positions in CMU spin-off companies are consistent and spelled out: 6% for exclusive licensing and 5% for non-exclusive licensing, retained through the first raising of \$2 million in funding or more. Additional equity percentages are taken in exchange for additional services, e.g., 1% for patent services and 1% for each of up to two years of laboratory use to incubate the start-up company.

Much of our life science research and development is done through collaborations, particularly with faculty of the University of Pittsburgh and clinicians of the Allegheny Health Network (AHN) and the University of Pittsburgh Medical Center (UPMC). CTTEC works with those institutions to commercialize the results of collaborative projects, often taking the lead if all parties agree that CTTEC’s expertise, experience and connections position the team for highest likelihood of success.

**Research Licensing Agreements**

Carnegie Mellon has in place standard agreements for technology licensing, as well as guidelines for start-up company formation. The latter features provisions that clearly delineate the university’s expectations for granting licenses to a start-up, the university’s equity position for

both exclusive and non-exclusive licenses to the start-up, terms for royalty payments based on milestones and capitalization of the company, and allowable roles in the company for founders who are Carnegie Mellon employees.

## **Training Students and Health Professionals**

As a post-secondary institution, we directly educate and train students and health professionals. On our own campus, we have courses and offer degrees in traditional areas including biology, chemistry and biomedical engineering. In addition we have specialized programs that offer degrees and/or certificates, including computational biology, the neural basis of cognition, biotechnology management, health business practices, and medical management. Representative programs are highlighted below.

### For students

- *Biological Sciences*—The Department of Biological Sciences’s areas of emphasis include biochemistry, biophysics, and structural biology; biotechnology; cell biology; computational biology and bioinformatics; developmental biology; genomics, proteomics, and systems biology; molecular biology and genetics; and neuroscience. It grants degrees at the Bachelor’s, Master’s and Doctoral levels.
- *Biomedical Engineering*—The Department of Biomedical Engineering (BME) provides training and grants degrees at the Bachelor’s, Master’s and Doctoral levels. Though established as a department in only 2002, it is now ranked 27th in the country as a graduate program and 17th as an undergraduate program. BME is also a partner with the University of Pittsburgh School of Medicine in the Medical Scientist Training Program, an MD-PhD degree program. Research within BME is concentrated in five foci: biomedical imaging (including the Center for Bioimage Informatics), computational biomechanics and medical devices, medical robotics, molecular and cellular biotechnology and regenerative medicine (including the Bone Tissue Engineering Center).
- *Computational Biology*—Through a generous donation, the Ray and Stephanie Lane Center for Computational Biology was established in September 2007. Key facets of the center re fellowships for visiting professors and post-doctoral fellows. Carnegie Mellon established an undergraduate computational biology program in 1987 and a Master of Science degree program in 1999. In the fall of 2005, we established a computational biology PhD program jointly with the University of Pittsburgh. The Center now has department status within CMU’s School of Computer Science.
- *Computational Neuroscience* – The Center for the Neural Basis of Cognition (which has several projects funded by CURE grants) offers a Ph.D. program designed specifically for students with a strong computational background in an area such as computer science, physics, mathematics or engineering and students who wish to work in a field in which computational approaches are applied to the understanding of the nervous system. It also offers a certificate program that is open to students pursuing Ph.D.’s in CNBC-affiliated departments, as well as three training programs designed to provide in-depth interdisciplinary training in particular subjects relevant to cognitive neuroscience (Multi-

Modal Neuroimaging Training Program, Behavioral Brain Research Training Program, and Interdisciplinary Graduate Education Research and Training Program).

- *Master of Science in Health Policy and Management (HCPM)*—The HCPM program teaches students how to think strategically about the economic, political, and financial environment in which health care is delivered. It provides an understanding of how to manage and lead organizations through the sea of changes sweeping across health care, and equips students with the technical and analytic tools—including IT—that will help them work smarter and more efficiently. This program can be completed on a part-time basis.

For health professionals:

- *Master of Medical Management (MMM)*—The MMM program offers management and leadership training to physician executives who wish to lead today's health care organizations and to shape the future of tomorrow's health care industry in a rapidly changing environment. Our curriculum builds upon and extends the skills and knowledge that physicians acquire in the American College of Physician Executives' Graduate Program in Medical Management.
- *Quality of Life Technology (QoLT)*—The QoLT Center, a joint Carnegie Mellon/University of Pittsburgh center funded by the National Science Foundation is developing and applying intelligent assistive technologies for older adults and people with disabilities. Faculty, staff and students in QoLT Center regularly address groups of clinicians and other health professionals through seminars and targeted outreach activities.

## **Commercial Research Development Training**

A cluster of projects and programs, involving faculty, staff, and trustees, forms a productive environment or ecosystem for innovation. These programs are especially focused on the critical early stages of the move from the university to the marketplace. These projects each function independently but also interact and interconnect across the campus. They include:

### The Center for Technology Transfer and Enterprise Creation (CTTEC)

CTTEC is a resource for any individual or group interested in commercial activity around Carnegie Mellon research. CTTEC staff members help faculty inventors through the various stages of commercialization; they assist in writing patent applications, finding venture funding, developing marketing strategies, and negotiating license agreements.

### The Center for Innovation and Entrepreneurship

In early 2013, CMU merged the Don Jones Center for Entrepreneurship and Project Olympus to extend their best practices campus wide. Based at the Tepper School of Business, the Center provides advice and assistance to faculty, staff and students who are considering creation of a spinoff company. It offers education and training in writing business plans, brokers connections to economic development organizations other early stage investors, and mentorship in devising

strategies to move basic research further along in the development and business cycles. The Center is responsible for fostering a culture of entrepreneurship throughout the university.

More than 10 percent of Carnegie Mellon undergraduates, including students from every college, are involved in Center's programs or classes each year. The Center holds an international business plan competition annually, attracting worldwide attention to Pittsburgh, and Carnegie Mellon MBA students often win top honors at this and other competitions. MBA students frequently turn to Carnegie Mellon engineers, computer scientists, chemists, or biologists for potential new-business ideas.

#### Quality of Life Technology (QoLT) Foundry

The QoLT Foundry was the commercialization program of the CMU/Pitt Quality of Life Technology Center. Several of its best practices have been adopted by the new Center for Innovation and Entrepreneurship. Those include employment of Executives in Residence (successful entrepreneurs brought in from the private sector to mentor entrepreneurially-minded researchers) and teams of interns (business, law and innovation management students from CMU and other local universities); performing early due diligence, industry and market analysis, and preliminary business model development; and proactively ferretting out spinoff company opportunities.

#### Other programs

The Master of Science in Biotechnology and Management (MSBTM) is a collaborative program of our Heinz College, our Mellon College of Science and our Tepper School of Business. The MSBTM program is the first of its kind in the US. It is being led by a former biotechnology executive whose experience includes being a VP at Johnson & Johnson and running his own durable medical equipment company.

The Tepper School also offers a Biotechnology MBA for students seeking to combine technical and scientific expertise with strategic business leadership skills. Students who select this Track are preparing for leadership at the intersection business and life sciences where both breadth and depth in managing regulatory, management, scientific and marketplace issues are required. The interdisciplinary program leverages expertise across the university: science, robotics, computer science, business management and biomedical engineering. Many students enrolled in this track belong to the Tepper School's Biopharma Business Student Club, the membership of which includes nearly 20% of the MBA student population.

### **Outreach to Businesses Regarding Recent Research Developments**

CTTEC personnel have numerous meetings with prospective funders (local technology-based economic development organizations, angel investors and venture capitalists) and local companies regarding Carnegie Mellon technologies and spin-offs. The CTTEC Director and staff routinely make presentations to audiences consisting of faculty, regional companies or both on topics such as technology transfer, intellectual property, patenting and company formation.

Carnegie Mellon's Corporate Relations group and Alumni Relations group also play important roles in connecting prospective licensees with technologies available for licensing. Indeed, it is

typical a company visiting the university will meet with representatives of those groups and CTTEC. Similarly, Corporate and Alumni Relations often collaborate to produce events outside of Pittsburgh to inform companies and university alumni about recent developments and technology transfer opportunities. Such events are often held in conjunction with major conferences and expositions, e.g., the annual Biotechnology Industry Association meeting.

## **Research Development Collaboration**

Close collaborations between biomedical researchers, lab scientists, computer and data mining specialists, and engineers are needed to develop technologies that exploit the potential of the second wave of biotechnology development. Such collaborations have been taking place successfully between Carnegie Mellon University and the University of Pittsburgh for well over a decade. The following programs are all formal, sustaining CMU/Pitt collaborations.

- *Center for Bioimage Informatics*—Members use advanced signal processing tools and machine learning tools to automate the generation of biological knowledge from cellular and tissue images. The initial focus has been on fluorescence microscope imaging; this will grow to include all major biomedical imaging modalities. This center was founded as a result of a \$9.4 million, five-year, multi-institution Information Technology Research grant from the National Science Foundation; Carnegie Mellon and the University of California, Santa Barbara are co-leading institutions on this grant award.
- *Center for Cognitive Brain Imaging*—Conducts functional magnetic resonance imaging (fMRI) studies to investigate high-level cognition, such as language comprehension, decision-making, and problem solving, using state-of-the-art scanners and techniques. Investigations also include other approaches used in conjunction with fMRI, most notably behavioral studies, computational modeling, eye fixation studies, and therapy studies of people with brain damage. It is one of the world's leading centers for imaging normal human brain function during thought processes, as well as imaging the effects of brain damage, therapy, and recovery on these processes.
- *Center for the Neural Basis of Cognition*—Studies the neural basis of cognitive processes, including learning and memory, language and thought, perception, attention, and planning. Promotes the application of research results to artificial intelligence, technology, and medicine. Many projects combine one or more of the following methodologies: computational modeling, behavioral analysis of normal behavior and effects of brain disorders on behavior, functional neuroimaging, and electrophysiological recording of neuronal activity. The CNBC's external advisory board recently identified the Center as one of the top three centers of Cognitive Neuroscience in the world.
- *Disruptive Health Technology Institute (DHTI)* —This program is a partnership of Highmark and its subsidiary, the Allegheny Health Network (AHN). DHTI was formally launched in June 2013 and announced the first investment of \$11 million from Highmark in a multi-year program aimed at increasing the affordability, simplicity, and accessibility of health care. This investment funds projects at CMU, typically with an AHN clinician as a collaborator, that have anticipated impact to a large population, are likely to provide substantial health care savings and improve patient safety and quality of life.

- *Medical Scientist Training Program*—This program is designed to produce dual degree graduates. The University of Pittsburgh School of Medicine confers the M.D. degree; the Ph.D. may be conferred either by the University of Pittsburgh Graduate School or by Carnegie Mellon. Over the past several years, many of these students have enrolled in Carnegie Mellon’s Biomedical Engineering Department and are doing research in the Healthcare Robotics Center.
- *Pittsburgh NMR Center for Biomedical Research*—An NIH-supported national Biomedical Technology Resource Center, bringing together scientists and clinical investigators in a concerted research program focusing on applications of magnetic resonance imaging (MRI) and spectroscopy (MRS) to biomedical sciences using animal models. Center facilities are available to other academic, medical, and industrial researchers. It is a national leader in the field. One of the research projects undertaken by the NMRI Center is the development of a non-invasive methodology to detect the early signs of graft rejection in organ transplantation by MRI using rodent models (supported by a major NIH grant of over \$3 million for five years), if successful, will replace the traditional invasive “biopsy” method to detect graft rejection in transplant patients and reduce healthcare costs. Magnetic resonance imaging (MRI) has also long been a strength and used variously to identify aberrant cell clusters to recognition of aberrant mental processing.
- *Pittsburgh Supercomputing Center (PSC)*—PSC provides state-of-the-art advanced computing resources to national scientists and engineering research communities; educates researchers in the use of supercomputers; introduces industrial firms to the benefit of supercomputing; and serves as a catalyst for campus-based research to advance computational science and techniques. The PSC has been the prime NIH supercomputing resource for biologic efforts for more than a decade. Multiple sequence alignment through supercomputing power will become more important with more genomes sequenced. Structural biology uses still greater processing power.
- *Quality of Life Technology Center*—This Carnegie Mellon/University of Pittsburgh collaboration is a prestigious National Science Foundation Engineering Research Center. Its goal is to allow two populations—older adults and people with disabilities—to live more independently by overcoming cognitive, perceptual and physical disabilities with information technologies and robotics. The team includes researchers in CMU computer science, robotics, engineering, social science and public policy departments and Pitt rehabilitation, engineering, geriatrics and nursing.
- *Molecular Biosensor & Imaging Sensor Center*—Funded as a National Technology Center by the National Institutes of Health Common Fund's *Building Blocks, Biological Pathways, and Networks* program, this effort was enabled by and builds upon research conducted through CURE Formula grants that Carnegie Mellon received in FY2002 and FY2004. The center is a partnership of Carnegie Mellon and the University of Pittsburgh. It is creating a powerful toolbox of intracellular fluorescent labels and biosensors that can be used to study many, if not all, the proteins in pathways and networks of living cells. Its fluorescent probe development program blends genetics, protein structure, nucleic acid structure and fluorescent dye chemistry. The probes will be genetically expressible so that exogenous macromolecules will not have to be transported into the living cells to be

studied. Probe technologies are being augmented with imaging and informatics to create tools that help other researchers obtain and manage large amounts of spatial and temporal information about pathways in living cells.