

University of Colorado Boulder Technology Transfer Office (TTO)

Economic Impact of Tech Transfer on the State and National Economy

Conducted by:

Business Research Division
Leeds School of Business
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Business Research Division

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EXECUTIVE SUMMARY

Research universities provide both foundational basic research and the potential for technology transfer that becomes enabling technology in commercialized products. Sometimes the technology leads to the formation of a new company. The University of Colorado Boulder Technology Transfer Office (TTO) manages the transfer of intellectual property created on the Boulder campus.

The TTO provided data on 409 licensee records representing 272 unique agreements between fiscal year 2014 and fiscal year 2018. A total of 245 paid license revenue to CU, 49 recorded follow-on sales, and 40 were CU startups that recorded a capital round. Awards spanned 34 states and 13 countries. Domestic agreements totaled 245, or 90.4% of the agreements, 95.8% of the license revenue to CU, 99.9% of the inferred product sales, and 100% of the start-up capital raised. More than 89% of the agreements are affiliated with the College of Engineering and Applied Science (57%) and the College of Arts and Sciences (32%).

From fiscal year 2014 through fiscal year 2018, TTO recorded:

- \$10.1 million in licensing revenue to the University of Colorado Boulder
- \$151.1 million in inferred sales by licensees related to CU technology
- \$593.6 million in capital funding for startup companies commercializing CU Boulder technology
- \$48.7 million in commercialization-specific grants to CU Boulder.

Removing overlapping funding from follow-on sales and license revenue, and from commercialization grants and license revenue results in mutually exclusive TTO-related economic activity. The estimated \$720.6 million in domestic TTO-related activity resulted in an economic impact on the national economy totaling \$1.9 billion from fiscal year 2014 through fiscal year 2018. This level of activity supported an estimated 11,545 job years over the five-year period (or an average of 2,309 per year), paying an estimated \$731.8 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$1.1 billion.

TABLE 1: ECONOMIC IMPACT OF TTO-RELATED ACTIVITY ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	4,617	\$339.4	\$413.1	\$720.6
Indirect Effect	2,349	\$157.5	\$255.0	\$446.6
Induced Effect	4,579	\$234.9	\$417.2	\$747.0
Total Effect	11,545	\$731.8	\$1,085.4	\$1,914.3

Much of the activity was recorded in Colorado, with \$592.4 million in TTO-related activity, leading to an economic impact of \$1.2 billion on the state's economy.

PROJECT PURPOSE

Research universities provide both foundational basic research and the potential for technology transfer that becomes enabling technology in commercialized products. Sometimes the technology leads to the formation of a new company. The purpose of this project was to quantify the economic impacts of technology transfer from the University of Colorado Boulder Technology Transfer Office (TTO) on the state and national economy.

According to TTO,

The Technology Transfer Office (TTO) ensures that CU Boulder and UCCS's world-class research creates world-class impact. Every day, we bring together industry partners, entrepreneurs and investors to help CU Boulder researchers solve important problems and improve quality of life worldwide.

With expertise in patents, copyrights and licensing, we help translate discovery into impact through transparent, flexible, best practice intellectual property management services, and connect campus researchers with a variety of commercialization programs in the university and the community. See <https://www.colorado.edu/techtransfer/> for more information.

DEFINITIONS

Gross Domestic Product (GDP): A measure of economic activity, GDP is the total value added by resident producers of final goods and services.

Gross Output (Output): The total value of production is gross output. Unlike GDP, gross output includes intermediate goods and services.

Value Added: The contribution of an industry or region to total GDP, value added equals gross output, net of intermediate input costs.

Labor Income: Total compensation of employees (wages and benefits) and sole proprietors (profits).

Employment Job Year: Equates to one job in one year.

Direct Impact: Initial economic activity (e.g., sales, expenditures, employment, production, etc.) by a company or industry.

Indirect Impact: The upstream (backward) economic activity impacted by purchases along a company or industry supply chain.

Induced Impact: Economic activity derived from workers spending their earnings on goods and services in the economy.

GENERAL METHODOLOGY

The Business Research Division conducted a study of the economic impacts of 272 unique tech transfer agreements from the University of Colorado Boulder from fiscal year 2014 through fiscal year 2018.

Per the terms of the agreements, data about licensed technology are remitted to TTO. No companies were contacted for this study. TTO cleaned the data and provided the BRD with summary statistics by agreement. The BRD used an economic input-output model, IMPLAN, to estimate the multiplier effect for TTO agreements, imputed sales, and capital funding. Results are disseminated as direct, indirect (supply chain), and induced (household) impacts.

License revenue, follow-on sales, and capital funding activities were classified using the six-digit North American Industry Classification System (NAICS). Licensing revenue with the University of Colorado was classified as Professional, Scientific, and Technical Services (541) for the Scientific Research and Development Services, which follow-on sales and capital funding were classified based on the NAICS corresponding to each licensee. Follow-on sales and funding were classified into seven industries based on their operating function:

- Manufacturing
- Information
- Real Estate and Rental and Leasing
- Professional, Scientific, and Technical Services
- Administrative and Support and Waste Management and Remediation Services
- Educational Services
- Health Care and Social Assistance

IMPLAN multipliers were obtained from MIG by matching the NAICS to IMPLAN's corresponding unaggregated sectors. The BRD converted the NAICS codes to the 536-sector IMPLAN input-output model. The TTO license revenue to the University of Colorado was modeled in the Professional, Scientific, and Technical Services sector. While the data span five fiscal years (2014-2018), license revenue, inferred sales, and capital funding were not reported by year. All activity was modeled in 2017 dollars, providing a conservative estimate of impacts.

Economic impacts are associated with tech transfer agreements, both when the technology is licensed and when the company records follow-on sales. This study quantifies sales activity directly linked to University of Colorado technology transfer agreements and estimates the economic multiplier effect of licenses and follow-on sales.

Overview of Economic Impact Analysis

This study estimates the economic impact using the IMPLAN input-output model. Results are disseminated in terms of direct, indirect, and induced impacts on employment, labor income, value added, and output. As well, the fiscal impacts were also estimated by the model.

Economic benefits refer to dollars generated and distributed throughout the economy. The sources of impacts that sum to economic benefits include capital expenditures and operating expenditures, including the off-site spending by employees and the spending on goods and services within the supply chain.

The multiplier effect of spending within the supply chain, or the indirect impact, estimates the indirect employment and earnings generated in the study area due to the interindustry relationships between the facility and other industries. As an example, consider the University of Colorado Boulder operating the research university in Boulder, Colorado. The university employs research faculty, teaching faculty, support staff, and students for operations. In addition, the university spends on goods and services to support its operations, leading to auxiliary jobs in the community in manufacturing, transportation, wholesale, retail, and so on—the **indirect impact**. Furthermore, employees spend earnings on goods and services in the community, leading to jobs in retail, accounting, entertainment, and so on—the **induced impact**.

Conceptually, the multiplier effect quantifies the economic ripple effect of economic activity. This ripple effect can be positive or negative depending if a company or industry is expanding or contracting. Multipliers are static and do not account for disruptive shifts in infrastructure without specifically addressing infrastructure changes. This model uses IMPLAN multipliers for the United States and Colorado using IMPLAN V3 and the most current available multipliers (2016).

TTO DATA

The University of Colorado Technology Transfer Office recorded 272 unique tech transfer agreements from fiscal year 2014 through fiscal year 2018. Of the 272 unique agreements between fiscal year 2014 and fiscal year 2018, a total of 245 paid license revenue to CU, 49 recorded follow-on sales, and 40 were CU startups that recorded a capital round.

Awards spanned 34 states and 13 countries. Information about the 272 unique agreements was spread across 409 records delineated by revenue type (e.g., royalty earned, royalty minimum, option fee, etc.). Domestic agreements totaled 245, or 90.4% of the agreements, 95.8% of the license revenue to CU, 99.9% of the inferred product sales, and 100% of the start-up capital raised. More than 89% of the agreements are affiliated with the College of Engineering and Applied Science (57%) and the College of Arts and Sciences (32%).

License Revenue

The University of Colorado's Technology Transfer Office collects data on licensing agreements per the agreement terms (see Appendix 1 for provided fields). From fiscal year 2014 to fiscal year 2018, a total of 272 agreements yielded \$10.1 million in licensing revenue to the University of Colorado Boulder. The largest 8 agreements represented 51% of license revenue, and the top 20 represented two-thirds of the revenue (252 agreements represented less than one-third of revenue). Colorado licensees represented 28.3% of the license revenue.

TABLE 2: LICENSE REVENUE TO CU

License Revenue	Number of Companies
0	27
\$1-\$25,000	184
\$25,000-\$50,000	30
\$50,000-\$100,000	14
>\$100,000	17
Average	\$37,276
Median	\$10,000

Inferred Sales

Inferred sales volumes based on the royalty agreements indicate company sales of \$151.1 million, averaging \$3.1 million across 49 companies.

TABLE 3: INFERRED LICENSEE SALES

Inferred Sales	Number of Companies
\$1-\$10,000	14
\$10,000-\$50,000	7
\$50,000-\$100,000	7
\$100,000-\$1M	11
>\$1M	10

Capital Funding

University of Colorado Boulder research leads to the spawning of new businesses. The formation of businesses typically includes a tech transfer agreement for the legal use of the technology by the startup company. There were 59 agreements associated with CU startups, of which 40 agreements were associated with raised outside capital totaling \$593.6 million between fiscal year 2014 and fiscal year 2018. One-third raised up to \$1 million, one-third raised between \$1 million and \$5 million, and a third raised over \$5 million (including 4 that raised over \$25 million).

TABLE 4: CU STARTUP CAPITAL RAISED

Capital Raised	Number of Companies
0	19
\$1-\$1M	13
\$1M-\$5M	13
\$5M-\$25M	10
>\$25M	4
Average	\$10,061,675
Median	\$650,000

Commercialization-Specific Grants to CU Boulder

The TTO manages commercialization grants on the University of Colorado Boulder campus. From fiscal year 2014 through fiscal year 2018, commercialization grants totaled \$48.7 million. These grants take the form of:

- Chancellor’s Innovation Fund
- Commercialization Gifts
- Advanced Industries Accelerator Proof of Concept Grants
- Advanced Research Projects Agency-Energy (ARPA-E) Grants
- Startup-Funded Research

The **Chancellor’s Innovation Fund** is funded by a portion of TTO licensing revenue. This program provided \$200,000 in funding over the past two years (\$100,000 in FY2017 and in FY2018).

Commercialization Gifts are gifts from investors wanting to de-risk early-stage tech prior to making an investment. This funding totaled \$200,000 in FY2018.

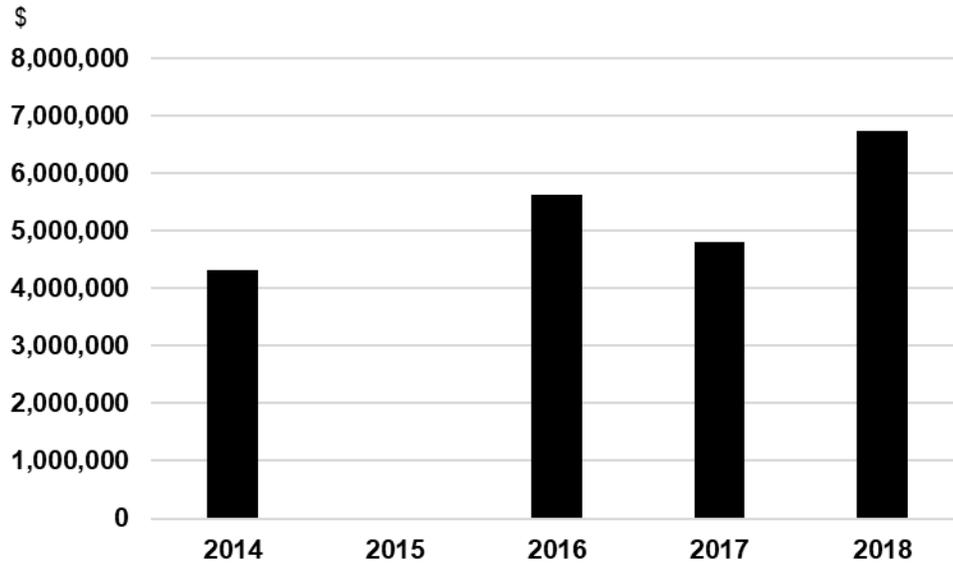
Advanced Industries Accelerator Proof of Concept Grants include funding from the Colorado Office of Economic Development and International Trade with 25% matching funds from the University of Colorado Boulder. This funding exceeded \$4.2 million from FY2014-FY2018, an average of over \$849,100 per year.

Advanced Research Projects Agency-Energy (ARPA-E) is a program of the U.S. Department of Energy. ARPA-E “advances high-potential, high-impact energy technologies that are too early for private-sector investment. ARPA-E awardees are unique because they are developing entirely new ways to generate, store, and use energy.¹” The TTO reported \$21.5 million in ARPA-E awards over the five fiscal years ending in 2018, averaging \$4.3 million per year, with a maximum of \$6.7 million in FY2018

¹ <https://arpa-e.energy.gov/?q=arpa-e-site-page/about>, retrieved December 12, 2018.

and a minimum of \$0 in FY2015. This funding is used for early-stage research and development at the University of Colorado.

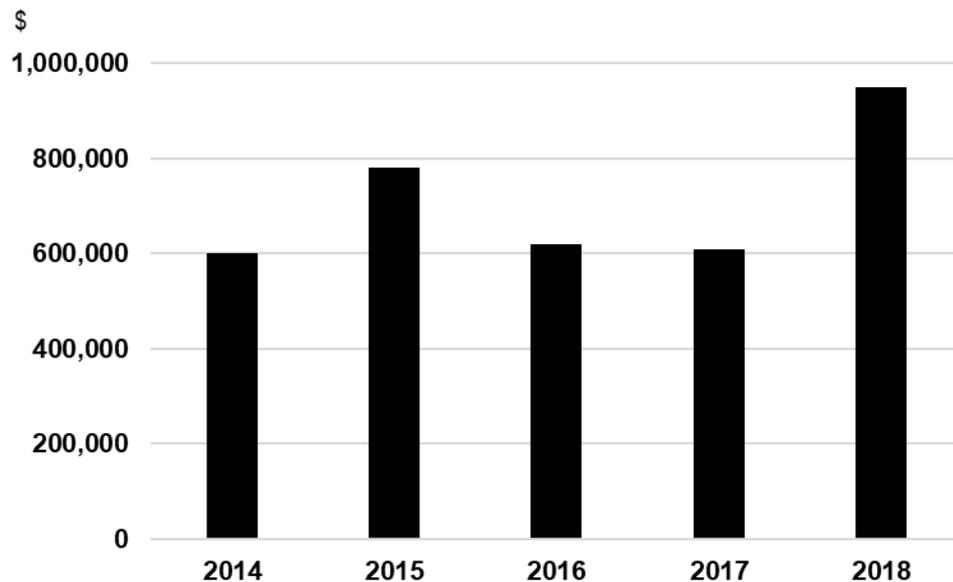
FIGURE 1: ARPA-E SUPPLEMENT, FY2014-FY2018



Patents

Patents protect the intellectual property of innovations developed by researchers at the University of Colorado Boulder. The TTO reported spending \$3.6 million on patent and trademark licenses over the five years ending in FY2018, averaging \$712,100 per year. Patent expenditures increased 56% in FY2018. Patents are a cost to the TTO, with a caveat that patent expenditures are reimbursable if technology (intellectual property) is licensed. Over half of patent expenditures between FY2014 and FY2018 were reimbursed (51.4%, or a total of \$1.8 million).

FIGURE 2: PATENT EXPENDITURES, FY2014-FY2018



ECONOMIC IMPACT

Economic impacts are associated with license revenue, follow-on company sales, capital funding, and commercialization grants. Removing overlapping funding from follow-on sales and license revenue, and from commercialization grants and license revenue results in mutually exclusive TTO-related economic activity. The estimated \$720.6 million in domestic TTO-related activity resulted in an economic impact on the national economy totaling \$1.9 billion from fiscal year 2014 through fiscal year 2018. This level of activity supported an estimated 11,545 job years over the five-year period (average of 2,309 per year), paying an estimated \$731.8 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$1.1 billion.

TABLE 5: ECONOMIC IMPACT OF TTO-RELATED ACTIVITY ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	4,617	\$339.4	\$413.1	\$720.6
Indirect Effect	2,349	\$157.5	\$255.0	\$446.6
Induced Effect	4,579	\$234.9	\$417.2	\$747.0
Total Effect	11,545	\$731.8	\$1,085.4	\$1,914.3

Much of the activity was recorded in Colorado, with \$592.4 million in TTO-related activity, leading to an economic impact of \$1.2 billion on the state's economy.

TABLE 6: ECONOMIC IMPACT OF TTO-RELATED ACTIVITY ON THE COLORADO ECONOMY, FY2014-18

Impact Type	Employment	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	4,266	\$292.5	\$331.7	\$592.4
Indirect Effect	1,661	\$100.4	\$154.6	\$261.3
Induced Effect	2,570	\$118.6	\$209.8	\$365.5
Total Effect	8,496	\$511.5	\$696.1	\$1,219.2

Economic Impact by Activity

The following section provides the economic impact for individual TTO-related activity. Note that the impact from license revenue, commercialization grants, follow-on sales, or capital funding cannot be summed because the sales are not mutually exclusive from the license revenue or the commercialization grants.

Economic Impact of License Revenue

Revenue from license agreements totaled \$10.1 million from fiscal years 2014 through 2018. Assuming this funding was primarily reinvested by the university in Professional, Scientific, and Technical Services, the economic impact of the license revenue totaled \$22.2 million on the state economy and \$27.2 million on the national economy. This level of activity supported an estimated 142 job years over the five-year

period (average of 28 per year), paying an estimated \$9.9 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$15.4 million.

TABLE 7: ECONOMIC IMPACT OF LICENSE REVENUE ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	38	\$4.0	\$5.5	\$10.1
Indirect Effect	42	\$2.7	\$4.3	\$7.0
Induced Effect	62	\$3.2	\$5.6	\$10.1
Total Effect	142	\$9.9	\$15.4	\$27.2

TABLE 8: ECONOMIC IMPACT OF LICENSE REVENUE ON THE COLORADO ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	41	\$3.9	\$5.2	\$10.1
Indirect Effect	42	\$2.4	\$3.7	\$6.1
Induced Effect	41	\$1.9	\$3.4	\$5.9
Total Effect	124	\$8.2	\$12.2	\$22.2

Economic Impact of Commercialization Grants

Commercialization grants include the Chancellor’s Innovation Fund, commercialization gifts, Advanced Industries Accelerator Proof of Concept grants, Advanced Research Projects Agency-Energy (ARPA-E) grants, and startup-funded research. This funding primarily engages research and development activities on campus. Funding totaled an estimated \$48.7 million from fiscal year 2014 through fiscal year 2018. Assuming the funding is used primarily for R&D, the economic contribution totaled \$106.4 million on the state economy and \$130.6 billion on the national economy. This level of activity supported an estimated 681 job years over the five-year period (average of 136 per year), paying an estimated \$47.3 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$74.2 million. Note: commercialization grants are partially funded by license revenue, thus, the economic impacts should not be summed.

TABLE 9: ECONOMIC IMPACT OF COMMERCIALIZATION GRANTS ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	183	\$19.1	\$26.4	\$48.7
Indirect Effect	202	\$13.0	\$20.8	\$33.6
Induced Effect	296	\$15.2	\$27.0	\$48.3
Total Effect	681	\$47.3	\$74.2	\$130.6

TABLE 10: ECONOMIC IMPACT OF COMMERCIALIZATION GRANTS ON THE COLORADO ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	196	\$18.9	\$24.7	\$48.7
Indirect Effect	200	\$11.5	\$17.8	\$29.5
Induced Effect	198	\$9.2	\$16.2	\$28.2
Total Effect	594	\$39.5	\$58.8	\$106.4

Economic Impact of Follow-On Sales

Inferred revenue by licensees totaled \$151 million domestically from fiscal year 2014 through fiscal year 2018. These revenues represent total sales of the products or services related to licensed technology from the University of Colorado Boulder. Inferred sales totaled \$34.2 million for companies domiciled in the state of Colorado. The economic impact of inferred sales totaled \$70.9 million in the state and \$416.5 million nationally. This level of activity supported an estimated 2,776 job years over the five-year period (average of 555 per year), paying an estimated \$149.9 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$226.5 million.

TABLE 11: ECONOMIC IMPACT OF FOLLOW-ON SALES ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	1,253	\$62.8	\$78.5	\$151.0
Indirect Effect	585	\$39.0	\$62.5	\$112.5
Induced Effect	938	\$48.1	\$85.5	\$153.0
Total Effect	2,776	\$149.9	\$226.5	\$416.5

TABLE 12: ECONOMIC IMPACT OF FOLLOW-ON SALES ON THE COLORADO ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	756	\$19.8	\$21.6	\$34.2
Indirect Effect	91	\$4.7	\$8.1	\$14.0
Induced Effect	160	\$7.4	\$13.1	\$22.8
Total Effect	1,007	\$31.9	\$42.7	\$70.9

Economic Impact of Capital Funding

Some licensees reported capital funding related to licensed technology. Often, when early-stage companies raise capital, it is used for investment in research and development, or in taking a product to market. Funding may also buy out early investors. Funding totaled an estimated \$515.4 million domestically, of which \$501.3 was to Colorado companies. Assuming the funding is used primarily for R&D, the economic contribution totaled \$1.02 billion on the state economy and \$1.35 billion on the national economy. This level of activity supported an estimated 8,011 job years over the five-year period

(average of 1,602 per year), paying an estimated \$529.2 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$776.2 million.

TABLE 13: ECONOMIC IMPACT OF CAPITAL FUNDING ON THE U.S. ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	3,161	\$255.3	\$305.2	\$515.4
Indirect Effect	1,539	\$104.0	\$169.3	\$296.8
Induced Effect	3,311	\$169.8	\$301.7	\$540.2
Total Effect	8,011	\$529.2	\$776.2	\$1,352.4

TABLE 14: ECONOMIC IMPACT OF CAPITAL FUNDING ON THE COLORADO ECONOMY, FY2014-18

Impact Type	Employment (Job Years)	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	3,280	\$250.6	\$281.2	\$501.3
Indirect Effect	1,336	\$82.3	\$125.7	\$212.9
Induced Effect	2,177	\$100.5	\$177.7	\$309.7
Total Effect	6,794	\$433.4	\$584.6	\$1,023.9

APPENDIX 1: STUDY NAICS CODES

NAICS	Description
325412	Pharmaceutical Preparation Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325510	Paint and Coating Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
326199	All Other Plastics Product Manufacturing
332312	Fabricated Structural Metal Manufacturing
333132	Oil and Gas Field Machinery and Equipment Manufacturing
333318	Other Commercial and Service Industry Machinery Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334519	Other Measuring and Controlling Device Manufacturing
335931	Current-Carrying Wiring Device Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339999	All Other Miscellaneous Manufacturing
511210	Software Publishers
517410	Satellite Telecommunications
532283	Home Health Equipment Rental
541330	Engineering Services
541519	Other Computer Related Services
541714	Research and Development in Biotechnology (except Nanobiotechnology)
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)
541910	Marketing Research and Public Opinion Polling
561110	Office Administrative Services
611310	Colleges, Universities, and Professional Schools
611710	Educational Support Services
621111	Offices of Physicians (except Mental Health Specialists)
621511	Medical Laboratories
621512	Diagnostic Imaging Centers
623990	Other Residential Care Facilities
624310	Vocational Rehabilitation Services

APPENDIX 2: DATA FIELDS

Data fields provided for this study included:

- Licensee
- Agreement ID
- City
- State
- CU Startup?
- If CU Startup, capital raised
- revenue
- reimbursements
- License revenue to CU
- Revenue Type
- Royalty rate (%)
- Inferred Product Sales
- Department 1
- Department 2
- Department 3
- Department 4