2015

Tech in Vermont: A Study of the Prevalence and Impact of Tech in the Green Mountain State

VERMONT
DEPARTMENT OF LABOR

Economic & Labor Market Information Division

Executive Summary

Technology, or tech, is the cornerstone of the modern economy.
It has revolutionized everything from the workplace to the household; from the productivity of firms to the efficiency of markets. The gravity of its influence on the modern economy can be exhibited by the number of people employed in tech in Vermont as well as the nation as a whole.
The Vermont Department of Labor has followed research methodology established by national partners and leveraged a summer internship program to produce this analysis and accompanying report.

STEM:

Scientific, Technology, Engineering, and Mathematics

STEM Core v. STEM Health?

According to the 2012 Standard Occupation Classification (SOC) Policy Committee, STEM fields can be broken into four sub-domains:

- 1: Life and Physical Science, Engineering Mathematics, and Information Technology Occupations
- 2: Social Science Occupations
- 3: Architecture Occupations
- 4: Health Occupations

For this study, occupations within STEM Core (1) and STEM Health (4) best fit the definition of a tech occupation. Because of the differences and impacts on the State of Vermont, the two were measured independently and together for both occupations and industries.

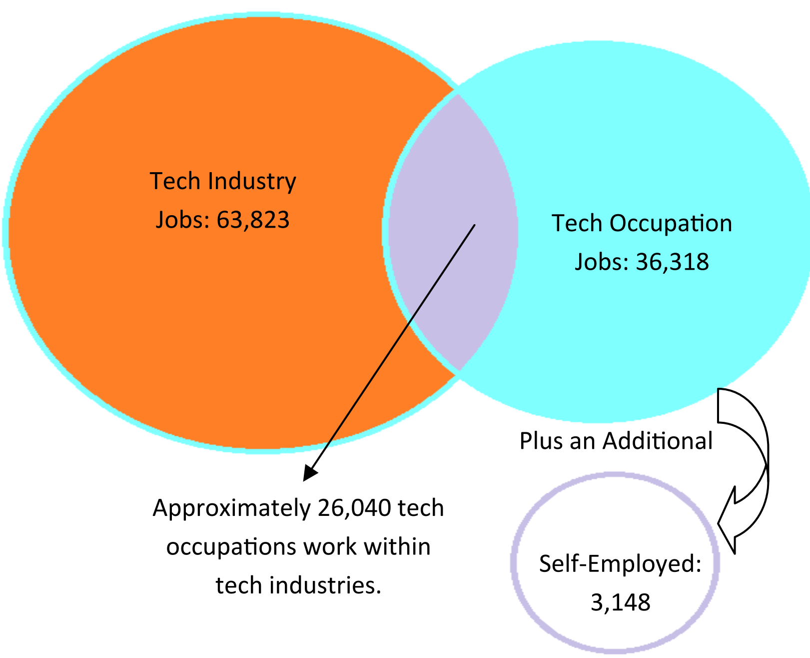
What is a tech occupation?

Tech occupations are scientific, engineering, mathematics, technician, and computer programming occupations that require an in-depth knowledge of the theories and principles of science, engineering, mathematics, or computer programming. These occupations need specialized education ranging from a vocational certificate to an Associate's Degree all the way through to Doctorate level training in order to fulfill their role within a given tech occupation.

What is a tech industry?

For the purposes of this study and consistent with national research, tech industries are defined by the concentration of tech occupations in them. Any tech industry that has a concentration of at least two and a half times the national average of tech occupations is considered a tech industry. The national averages were 6.1% for STEM Core and 6.3% for STEM Health.

Tech in Vermont ~ Tech industry employment in 2014 was estimated at 63,823 (21.0%). Tech occupation employment, on the other hand, was 36,318 (12.1%). Once the overlap is removed, the total number of tech jobs in Vermont exceeds 74,000 accounting for over 24% of all covered employment opportunities in the state. An additional, 3,148 jobs are estimated to be self-employed tech positions.



Tech industry Employment 2005-2014

Between 2005 and 2014, tech industry employment increased by 4,879, an average annual rate of increase of 0.9%. This rate exceeds the growth rate of total employment in Vermont (+0.1%) over the same time period. Tech is gaining relative share of the Vermont economy.

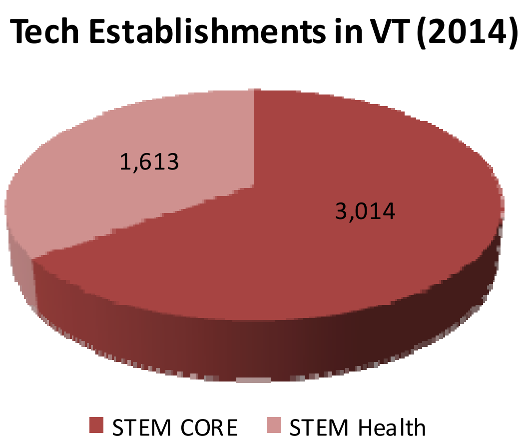
Years	Tech Industry Employment	% Change by Year
2005	58,944	
2006	59,541	1.0%
2007	61,484	3.3%
2008	62,210	1.2%
2009	61,018	-1.9%
2010	61,712	1.1%
2011	62,297	0.9%
2012	62,740	0.7%
2013	64,017	2.0%
2014	63,823	-0.3%
Average Annual % Change (2005-2014)		
Tech Industry Employment		0.9%
Total Employment in VT		0.1%

It is projected that between 2014 and 2022, there will be an increase in total tech employment of 4,765, approximately 0.9% on an average annual basis. This exceeds the projected rate of growth for all occupations in Vermont (0.8%).

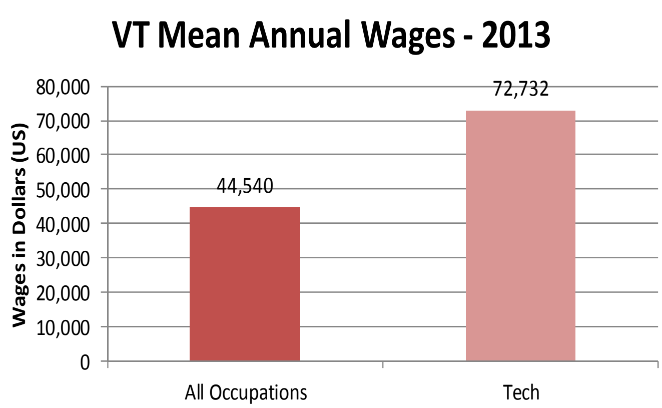
Years	STEM CORE Industry Employment	STEM HEALTH Industry Employment	Total Tech Industry Employment
2014	25,789	38,034	63,823
2022	26,122	42,465	68,587
Annual Average % Change (2014-2022)	0.2%	1.4%	0.9%

Because of tech industry employment's importance in the Vermont economy, a model was created to measure how many additional jobs are supported by a single tech job, referred to as the employment multiplier. The model shows that depending on the industry or group of industries, the tech employment multiplier varies. For example, for every STEM Core Services-Providing industry job created, an additional 1.3 jobs are added to the economy.

Industries	Employment Multiplier
Professional, Scientific, and Technical Services (NAICS 541)	0.7
STEM Core	2.1
STEM Health	0.9
STEM Core Services-Providing	1.3



There are approximately 4,627 tech establishments in Vermont. STEM Core accounts for 65.1% and STEM Health accounts for 34.9% of these establishments. On average STEM Health establishments have a greater number of employees per establishment than STEM Core.



Tech jobs in Vermont make 63.3% more in annual average wages than the state average. This 'wage premium' adds an additional $280 million and supports through induced effects approximately 4,600 jobs in the Vermont economy.

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Acknowledgments

As with all endeavors of research, the journey of research as well as the finished product is accomplished inevitably with the help of other people. This project was by no means an exception. The Vermont Department of Labor's Economic and Labor Market Information Division would like to explicitly mention those to whom we are very grateful in no particular order.

The U.S. Department of Labor's Employment and Training Administration's (ETA) provides tremendous support and makes state specific studies possible. In addition, ETA support allows for the Vermont Department of Labor to have an internship program which was instrumental in the design and completion of this study in particular.

A great deal of thanks is owed to the Vermont Technology Alliance (VtTA) for their generous input and feedback.

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http://www.dol.gov/

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Introduction

In recent years, the integration of technology within the workplace has been a predominant trend within the labor market. Technology has helped increase the productivity of both domestic and international firms. The purpose of this research is to understand the scope and impact of the tech sector in Vermont. Moving forward into the 21st century, it is imperative that we understand how exactly technology has effected and will continue to effect Vermont's economy.

The biggest challenge in defining tech and collecting relevant data is a lack of consistent and uniform tech taxonomies for either industries or occupations. Neither the North American Industry Classification System (NAICS) nor the Standard Occupational Classification (SOC) manual have stand-alone definitions of tech industries or tech occupations. Using several primary and secondary sources, the Vermont Department of Labor (VDOL) adopted its own definition of tech after a comprehensive inventory of national research on the subject. However, it is necessary to recognize that researchers make educated decisions to meet the requirements of any study. What works for Vermont may not work for other states; just as what has worked for other entities may not necessarily work for Vermont.

The purpose of this research was to expand our knowledge of the Green Mountain state and its place in the new tech economy. In so doing, generations of Vermonters can understand how the state has and will continue to evolve in the wake of tech.

Section 1: Methods

Occupation and Industry Definition

In 2013, the Workforce Information Council (WIC) and the State of Idaho published a report on the state of tech in Idaho and the United States using 2012 data. This report defined occupations as tech using a definition produced by Daniel Hecker of the Bureau of Labor Statistics (BLS). For VDOL's study, the authors decided to use those definitions adopted by the WIC/Idaho report to define the scope of tech occupations. This list and definition produces a thorough and representative list of tech occupations. This list provided 161 occupations, with 97 falling under the Science, Technology, Engineering, and Mathematics (STEM) Core subdomain and 64 falling under the STEM Health subdomain, which were both defined by the Standard Occupation Classification policy committee[1].

Defining an industry as tech is a more difficult and subjective activity. The authors decided after much research, internal discussion, and agreement with industry partners, that the model used by WIC/Idaho which is similar to previous tech studies would be used. This model uses an occupation concentration of tech within industries to define an industry as tech. As in the WIC/Idaho report, this study decided that an industry would be considered tech if it has a concentration of tech occupations greater than or equal to 2.5 times the national concentration average. When looking at concentration multiples, 2.5 was chosen because it produced a natural break in the data. Industries included at a 2.0 multiple worked, however, included were industries that hardly met the threshold and did not pass a logic test. When increasing the threshold to 2.5, numerous industries did not meet the new requirement and this satisfied further logical scrutiny. Increasing the multiple to 3 found important industries being excluded from the study. This method has also been utilized by numerous other authors, including Daniel Hecker of the BLS who has published many reports on tech and is often cited in other tech studies. The 2.5 occupation concentration threshold produced a list of 33 STEM Core industries and 13 STEM Health industries that this report classifies as tech.

To get an accurate estimate on occupation concentrations for all industries, the BLS Projections Division provided VDOL with the most recent occupation concentrations available. The 2013 concentrations were used because 2014 concentrations were not yet available. Thus, for this report 2013 concentrations were used to define industries as tech. Those concentrations have been applied to the analysis of 2014 Quarterly Census of Employment and Wages (QCEW) industry data, Occupational Employment Statistics (OES) occupational data, and Occupation Projection data.

Historic Industry Trends

To quantify the size of tech in Vermont, QCEW data is used to derive employment in all industries defined as tech. Using raw Economic and Labor Market Information (E&LMI) data allowed for a more accurate count for the aggregate employment data because values were not impacted by suppressed data. These data are used to derive the relative size of the tech industry in the state by taking total statewide tech employment and dividing it by total Vermont QCEW employment. This process was replicated for every year from 2005-2014.

Wage Data

This study uses occupation based information instead of industry data for a wage analysis. Despite the limitations of OES data (discussed in *Limitations of Data*), focusing on individual occupation wages rather than total industry wages paints a clearer picture. When one looks at wages from an industry perspective, this includes all tech and

[1] See Appendix 1 for full industry and occupation lists and Appendix 4: Review of Relevant Literature for more information on STEM and the SOC definitions.

non-tech occupations employed in it. This study concluded that occupations would display a more accurate representation of wages because they are specific only to those tech occupations, isolated from non-tech occupations which an industry approach would have necessarily taken into account. When looking at the annual mean wages of STEM Core and STEM Health, STEM Health is significantly different than the findings of the WIC/Idaho study, primarily because the WIC/Idaho study used the Quarterly Workforce Indicators (QWI), an industry based dataset. This study uses an occupation based dataset to find the mean annual wages.

When looking at mean annual wages, postsecondary teachers and instructors related to STEM fields were left out of the analysis. This is because the reporting of these can be inconsistent and non-representative of actual wages. Because of these issues, the occupations in minor group “25-1000,” postsecondary teachers, were removed and considered outliers when conducting wage calculations.

Self-Employment

The data used for estimates of self-employment comes from E&LMI’s Occupational Projections data as well as OES data from both 2012 and 2014. The Occupational Projections model takes into account instances of self-employment for its base year which, in this case, was 2012. OES, on the other hand, is an employer survey and therefore only captures people working within firms by occupation. By subtracting the Occupational Projections’ 2012 estimate by the OES 2012 estimate, an estimate of the number of self-employed for each occupation was produced. Because Occupation Projections data for 2014 has not been produced yet, the authors have produced a “relative-share factor”. This factor calculates the incidence of self-employment for each of the 86 occupations. It first takes the difference between the Occupation Projections for 2012 and OES 2012 and then divides it by the OES 2012 estimate. In essence, it displays the percentage of self-employed for each occupation. By multiplying the “relative-share factor” by OES 2014 estimates, a 2014 tech self-employment estimate is produced for each occupation.

REMI Input-Output Model

Regional Economic Models, Inc.[2] produces an economic impact model known as the REMI model. VDOL in partnership with the Vermont Agency of Commerce and Community Development (ACCD) utilized the REMI model to calculate the impacts of tech employment on the Vermont economy. The REMI model is built to analyze the economic linkages, exchanges that take place in the economy, and to map the impact and effects of each dollar spent in the economy by an industry. The total economic impact of an economic shock is comprised of three parts:

- Direct Impacts: These are the direct effects of an observed industry which include, but are not limited to employment, compensation, investment, etc.
- Indirect Impacts: These are employment, investment, compensation, and other activities of tertiary businesses and industries that support the industry being analyzed.
- Induced Impacts: These are employment, compensation, etc. associated with household spending of employees who work in industries directly and indirectly affected by the analyzed industry.

The REMI model was used to measure employment multipliers of different types of tech employment in Vermont. Vermont tech was broken down into Goods-Producers, Services-Providers, STEM Core, STEM Health, and a case study of Professional, Scientific, and Technical Services (NAICS Code 541).

[2] REMI: Regional Economic Models, Inc., Amherst, Massachusetts

REMI allows the user to analyze individual (sub)sectors at the 3-digit NAICS level for Vermont. Because the analyses in this report were done at a more specific and selective 4-digit NAICS level, there are more 4-digit NAICS industries included in the total 3-digit NAICS subsector. To adjust for possibly over representing tech when modeling, the 3-digit tech industries employment levels were divided by the proportion of 4-digit employment in the 3-digit sub sector. This produced a concentration of tech within the 3-digit subsector and allowed us to adjust for the possible over-representation by applying the correct concentration to all inputs and variables.

In addition to the employment multiplier, the REMI model is used to measure the impact of the wage premium of tech workers. Tech occupations have higher average wages and therefore, have higher impacts in the Vermont economy. The model is utilized by inputting the additional wages created by the tech premium and measuring the effect of those.

Limitations of Data

Self-Employment
The study's tech occupation list contains 161 occupations, 97 of which are STEM Core and 64 of which are STEM Health. E&LMI's Occupational Projections were used as a base for the self-employment statistics because it takes into account the number of self-employed for any occupation. However, the Occupational Projections only contained information on 87 of the 161 tech occupations. This is primarily due to the fact only some of the occupations include a large enough number of self-employed individuals to publish. In addition, because there was no OES 2012 data on one of these occupations (29-1129 Therapists, all other), our list was reduced to 86. Thus, our self-employment estimates for both 2012 and 2014 are conservative because of the absence of data on 75 occupations (46.6%). Further, the Occupational Projections self-employment estimate are derived from national employment patterns and are not specific to Vermont. The actual number of self-employed tech workers may be significantly higher than reported here.

Historic Industry Trends
The main limitation of looking at aggregate industry employment year-by-year is that QCEW code changes are not retroactively amended. This means that if a company moves from one industry to another, this would show an increase in the employment for a specific NAICS code in one year when in fact these jobs were not created but, rather, moved from a different code.

Wage Data
One limitation of the data used to look at occupation mean annual wages is how the information is collected. When OES collects information on wages, there is an hourly rate scale with corresponding annual wages that are based off of a 2,080 hour year. Because of this, the wages are marked in ranges and some occupations may not have a 2,080 hour work year.

REMI Input-Output Model
REMI produces projections based off of a linear model. In other words, the constraints of the model, as a result of its linear nature, cause it to lose accuracy when larger inputs are used to shock the model. It becomes harder for the model to properly forecast when inputs become very large and their economic linkages are amplified within the economy. This is important for a study like this because the impact modeling had to be limited to small shocks at the margin versus a comprehensive industry analysis which would not have been credible as tech is a significant part of the Vermont economy.

Section 2: Results

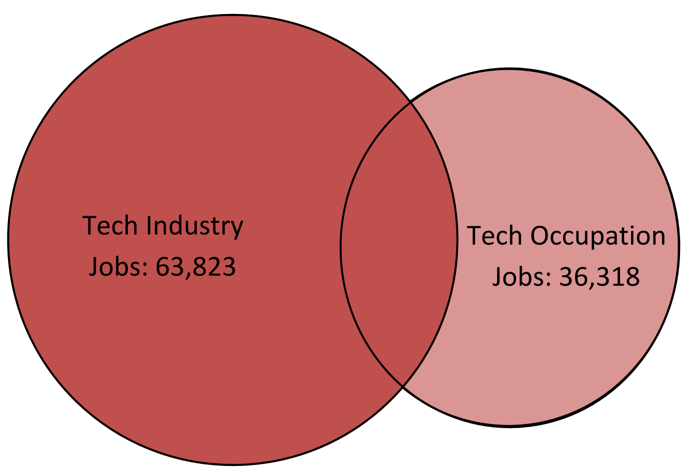
The following section is an analysis of available data on tech industries and occupations in Vermont. The results section analyzes E&LMI and BLS data, both at the state and national levels, including QCEW, OES, as well as industry and Occupational Projections data.

Analysis of E&LMI and BLS Data

Tech industries employ more than 63,000 workers with various skills and specialties whether administrative or technical in nature. Despite being tech or non-tech in nature, these occupations are necessary for the productivity of firms within these industries. For this study, tech industry employment can be divided into two groups: non-tech jobs (lawyers, accountants, etc.) and tech jobs (web developers, statisticians, etc.). In addition to the jobs within tech industries, tech occupations may also exist in non-tech industries. The goal of this study is to capture technology in Vermont by examining tech jobs in tech industries, non-tech jobs in tech industries, and tech jobs in non-tech industries.

Using QCEW and OES data for 2014, total tech industry employment in Vermont, as demonstrated in the Venn diagram below, is calculated at 63,823 which includes both tech and non-tech jobs (Figure 1). Total tech occupation employment is calculated at 36,318 for both tech and non-tech industries. In Vermont, approximately 40.8% of tech industry jobs are held by tech occupations, or 26,040 jobs. In comparison, the national percentage of tech industry jobs in tech occupations is 39.5%. This statistic is illustrated by the overlap between the tech occupation and tech industry circles below.

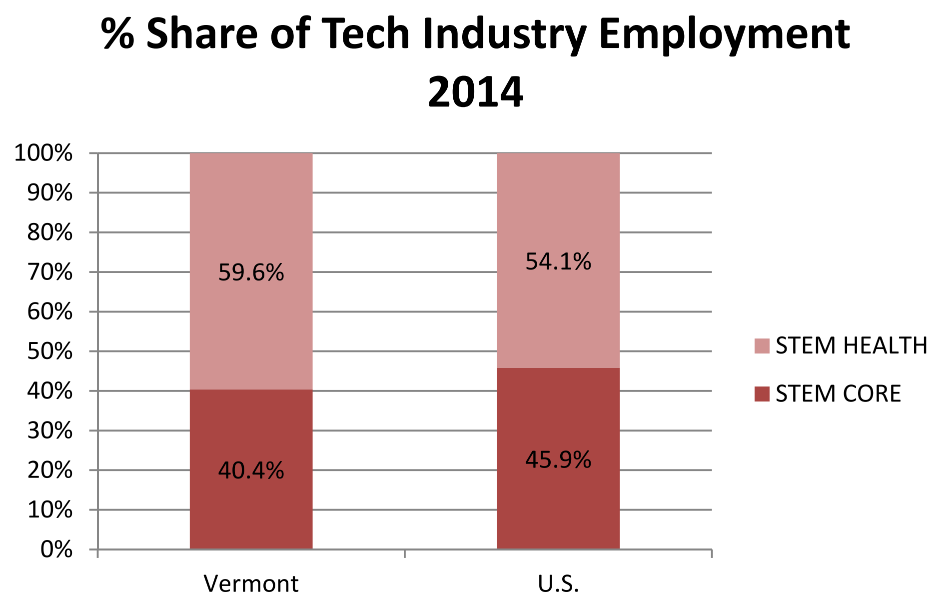
Figure 1



Approximately 26,040 tech occupations work within tech industries

Following the precedent of the WIC/Idaho study, this study uses a definition of tech occupations based on two of the four subdomains of STEM occupations identified by the SOC policy committee: 1.) Life and Physical Science, Engineering, Mathematics, and Information Technology occupations; and 2.) Health occupations. Respectively, these are referred to as STEM Core and STEM Health occupations. Likewise, tech industry data is divided into STEM Core and STEM Health industries (identified at the four-digit NAICS level) based the concentration (2.5 or greater) or prevalence of tech occupations.

Figure 2

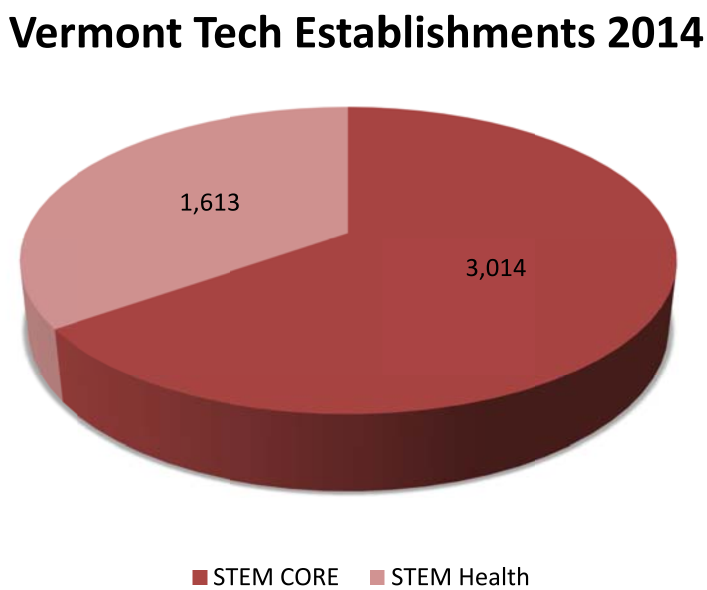


STEM Core employment is estimated to be approximately 40.4% of total tech industry employment in Vermont (Figure 2). STEM Health employment comprises the remaining 59.6%. Vermont exceeds the national STEM Health industry average of 54.1%, while STEM Core falls below the national average of 45.9%.

The total number of tech jobs in tech industries, non-tech jobs in tech industries, and tech jobs in non-tech industries is estimated to be about 74,101, or 24.3% of Vermont's total employment. Nationally, tech employment makes up about 25.4% of total employment.

In total, there are approximately 4,627 tech establishments in Vermont. STEM Core establishments make up 65.1% (3,014) of all tech establishments (Figure 3). STEM Health makes up approximately 34.9% (1,613). Though there are fewer STEM Health establishments than STEM Core in Vermont, there is a higher concentration of employment in STEM Health establishments than STEM Core. In short, this means that on average STEM Health firms employ more people compared to STEM Core firms.

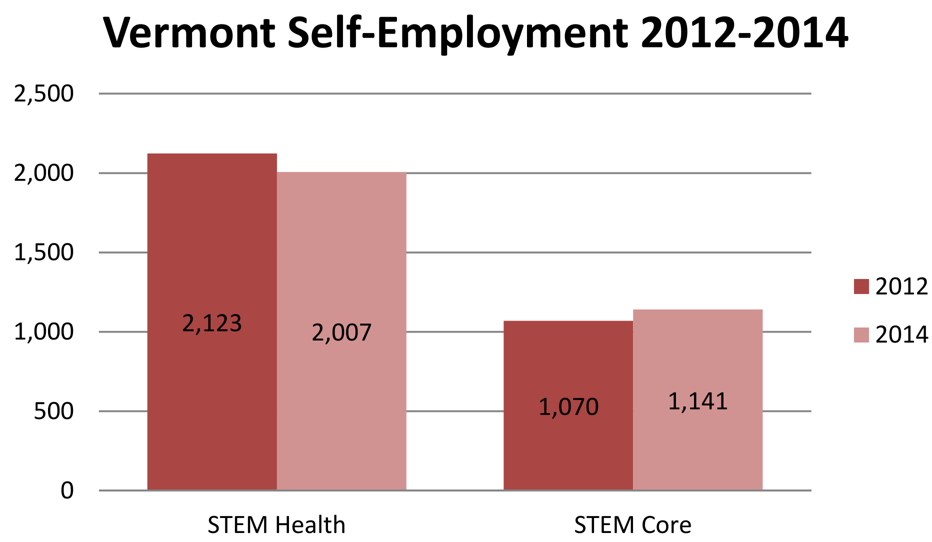
Figure 3



Self-Employment

An estimate of the number of self-employed was calculated for both 2012 and 2014 from tech related occupations in Occupational Projection data. Total tech self-employment for 2012 was estimated at 3,193 (Figure 4). In 2014, tech self-employment was 3,148, a net decrease of 45 jobs or -0.7% on an average annual rate of change. While overall the number of self-employed went down, a different picture is painted when STEM Health and STEM Core are differentiated.

Figure 4

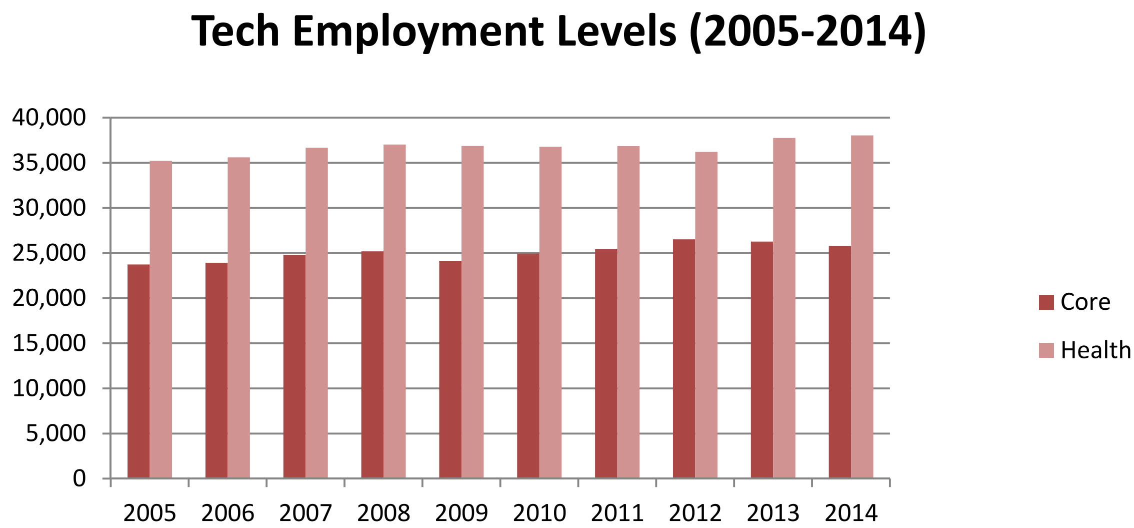


Between 2012 and 2014, STEM Health self-employment had decreased from 2,123 to 2,007, an annual average percent change of -2.8%. With the increase in STEM Health employment seen elsewhere, this decrease in self-employment could be explained by the consolidation and/or change of the health care delivery system due to reform. On the other hand, STEM Core self-employment had risen from 1,070 to 1,141, roughly a 3.3% average annual increase. In 2014, approximately 8.0% of tech occupations in Vermont were self-employed.

Historic Industry Trends

Using Vermont QCEW data from 2005-2014, an aggregate size of tech employment in Vermont was generated to look at its magnitude over time. This analysis showed that STEM Core, STEM Health, and the total tech employment in Vermont have increased over the past 10 years. STEM Core has seen an increase from 23,734 employees in 2005 to 25,789 employees in 2014. STEM Health has also seen growth from 35,210 employees in 2005 to 38,034 employees in 2014. Over the ten year period of analysis, this translates to an 8.7% increase in STEM Core employment, an 8.0% increase in STEM Health, and an overall increase of 8.3% in all tech employment. Over this time period, total Vermont employment grew by 1.2% for the ten year period. In terms of average annual increases in employment, tech increased by 0.9% versus 0.1% for all Vermont employment.

Figure 5



The size of tech industry employment compared with total industry employment was measured over the 2005-2014 time period as well. This analysis indicates that STEM Health industries in Vermont maintained a larger size in the state than STEM Core industries. The 2014 size of STEM Core and STEM Health combined was 21.0% of total Vermont employment.

Table 1

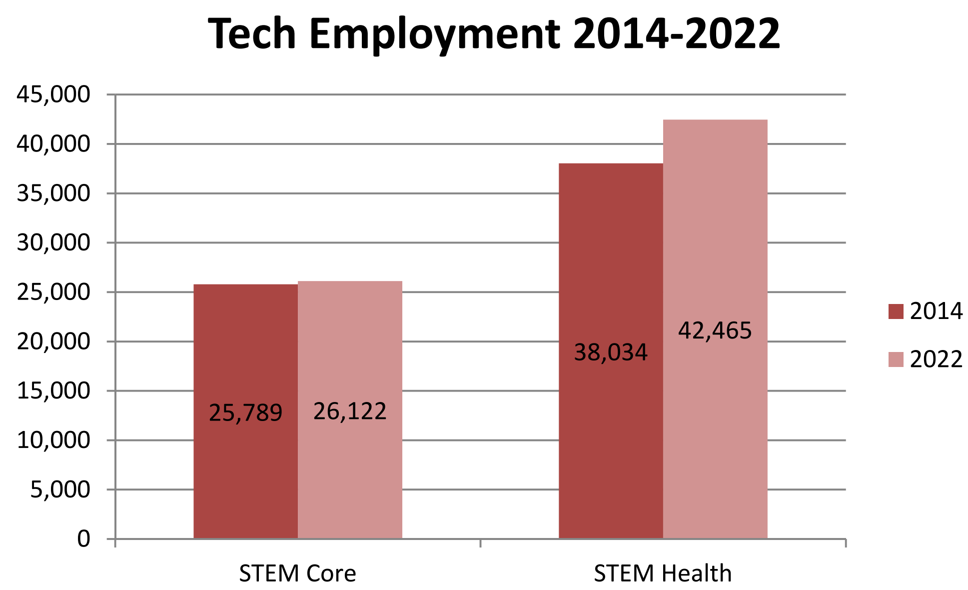
Percent of Total Vermont Industry Employment (2005-2014)

Year	All Tech [a]	STEM Core = [b]	STEM Health + [c]
2005	19.6%	7.9%	11.7%
2006	19.7%	7.9%	11.8%
2007	20.3%	8.2%	12.1%
2008	20.6%	8.3%	12.2%
2009	20.9%	8.3%	12.6%
2010	21.1%	8.5%	12.5%
2011	21.1%	8.6%	12.5%
2012	20.9%	8.9%	12.1%
2013	21.2%	8.7%	12.5%
2014	21.0%	8.5%	12.5%

Industry Projections

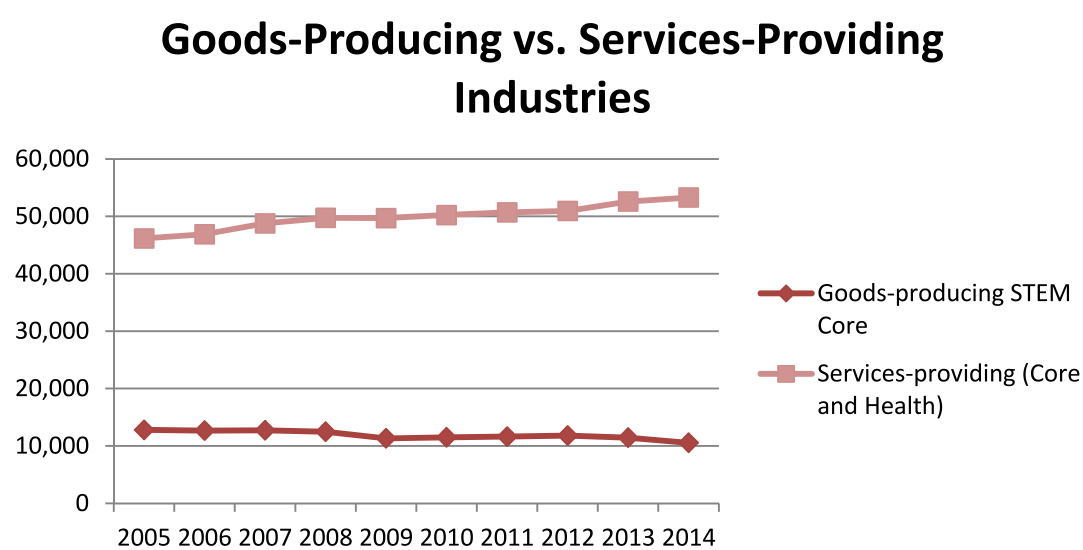
A cross-referencing of the QCEW 2014 data and 2022 Industry Projections of tech employment between 2014 and 2022 shows a projected rise of 4,765, or an average annual rate of change of 0.9% (Figure 6). When broken down, there is a projected net increase for STEM Core employment of 333, an average annual rate of change of 0.2% and a projected net increase for STEM Health employment of 4,431, or an average annual rate of change of 1.4%.

Figure 6



Goods-Producing versus Services-Providing Tech Industries

Figure 7

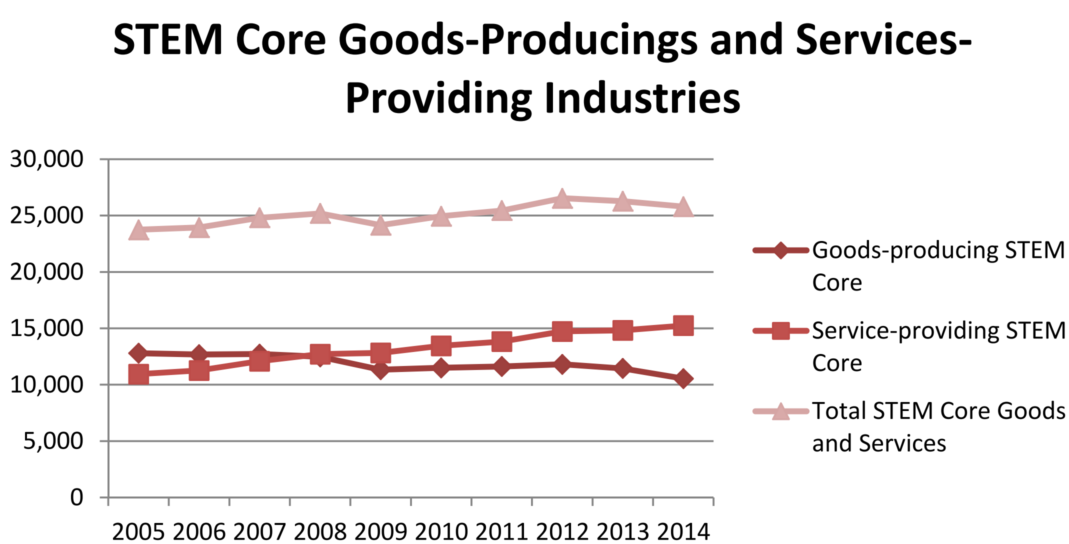


Of the 46 tech industries classified in this study, there are 16 goods-producing industries and 30 services-providing industries and these can be viewed in Appendix 2. Of the 33 STEM Core industries, 16 are goods-producing and 17 are services-providing. All 13 STEM Health industries are services-providing industries. Between 2005 and 2014, goods-producing industries saw a declining average annual rate of change in employment of approximately 2.1%. Services-providing industries, on the other hand, saw an average annual rate of change increase of approximately

1.6%. This indicates a significant contrast between goods-producing versus service-providing industries which impacts how one looks at STEM Core industry data and its future.

All the goods-producing industries in this study are found in STEM Core.   Therefore, the previously mentioned average annual decline of 2.1%, between 2005 and 2014, is directly related to STEM Core. STEM Core services-providing industries, in contrast, saw an average annual increase of 3.8% over the same time period. STEM Core goods-producing and services-providing industries as a whole saw an average annual increase of about 0.9%. STEM Health, which is only comprised of services-providing industries, saw an average annual growth rate of 0.9% over the same time period. It can be seen that, despite shrinking goods-producing industries, tech is still flourishing and growing because of the services-providing industries. Even with the decline in goods-producing, tech is on an upward trend and this is important for understanding how technology has impacted employment. For certain industries (e.g. goods-producing), technology has revolutionized the way business is done leading to greater efficiency and consequently causing a disruption in the demand for labor. Alternatively, for services-providing industries, technology has created whole new markets with demands for employees with new, emerging skillsets leading to tremendous growth and providing a glimpse of the future economy.

Figure 8



Wage Data
According to 2014 OES data, Vermont occupations have a mean annual wage of $44,540. In Vermont, the majority of tech occupations had mean annual wages above the statewide mean annual wage for all occupations. In fact, of all occupations that are STEM Core, only four had a mean annual wage below the Vermont mean annual wage. These included Forest and Conservation Technicians, Agricultural and Food Science Technicians, Biological Technicians, and Chemical Technicians. They showed mean wages of $36,370; $41,160; $41,830; and $43,140, respectively.

The mean annual wages for STEM Health showed more of a range than STEM Core. The highest mean wage was shown to be $204,760 and the lowest was $30,740. While only four occupations fell below the Vermont mean annual wage for STEM Core, eleven occupations fell below that mark in STEM Health.

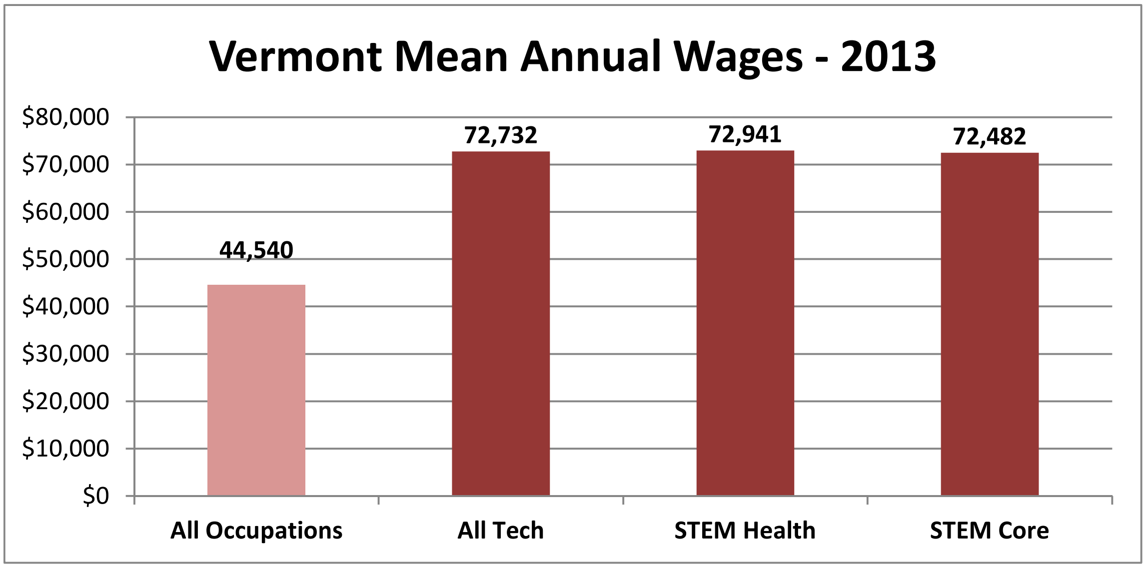
Table 2

STEM Core (2014)		
5 Highest Mean Annual Wage		
SOC	Occupation Title	Mean Annual Wage
19-2012	Physicists	$157,130
11-3021	Computer and Information Systems Managers	$131,770
11-9041	Architecture and Engineering Managers	$115,500
15-1133	Software Developers, Systems Software	$113,610
15-2011	Actuaries	$111,600
5 Lowest Mean Annual Wage		
SOC	Occupation Title	Mean Annual Wage
19-4093	Forest and Conservation Technicians	$36,370
19-4011	Agricultural and Food Science Technicians	$41,160
19-4021	Biological Technicians	$41,830
19-4031	Chemical Technicians	$43,140
17-3025	Environmental Engineering Technicians	$45,220

STEM Health (2014)		
5 Highest Mean Annual Wage		
SOC	Occupation Title	Mean Annual Wage
29-1021	Dentists, General	$204,760
29-1022	Oral and Maxillofacial Surgeons	$197,600
29-1067	Surgeons	$191,470
29-1066	Psychiatrists	$185,050
29-1069	Physicians and Surgeons, All Other	$182,160
5 Lowest Mean Annual Wage		
SOC	Occupation Title	Mean Annual Wage
29-2053	Psychiatric Technicians	$30,740
29-2041	Emergency Medical Technicians and Paramedics	$30,770
29-2051	Dietetic Technicians	$31,990
29-2052	Pharmacy Technicians	$32,600
29-2056	Veterinary Technologists and Technicians	$33,180

In 2014, the mean annual wage of all tech occupations was $72,732. STEM Core occupations have a mean annual wage of $72,482 and while STEM Health has a mean annual wage of $72,941. The combined mean annual wage for tech occupations in both STEM Core and STEM Health is approximately 63.3% higher than the mean annual wage of $44,540 for all Vermont occupations.

Figure 9



Preliminary Modelling Results

To attempt to better understand the impact of tech in Vermont, an input-output modelling program, REMI, was used to measure how tech interacts with the state economy. This provides an alternative and detailed look at how tech links with the Vermont economy as a whole and provides quantitative measures of the economic linkages. It is important to note, however, the data are preliminary.

Employment Multiplier Effect
One commonly used method to illustrate the impact of an industry or sector is by looking at an employment multiplier effect. This output suggests to the reviewer how many jobs are added by the introduction of one job in any given sector. In the case of this study, how many Vermont jobs are created by the addition of one tech job?

As the REMI model is industry based, this analysis looked at a number of specific scenarios in order to understand tech's impact on employment levels in the Vermont economy. In particular, we separately analyzed the impact of adding 1,000 jobs to each of the following: STEM Core industries, STEM Health industries, services-providing STEM Core industries, and a specific case study of Professional, Scientific, and Technical Services (NAICS 541). The outcomes of these models are illustrated in Table 3 below.

Table 3

Industries	Employment Multiplier
Professional, Scientific, and Technical Services (NAICS 541)	0.7
STEM Core	2.1
STEM Health	0.9
STEM Core Services-Providing	1.3

The above table describes how many additional jobs are created by the introduction of a tech job in Vermont. As shown, when a tech job is added in STEM Core, 2.1 additional jobs are created in the Vermont economy. This result is heavily influenced by the goods-producing industries found in STEM Core. As previously discussed, the employment levels in this part of the tech industry are under greater pressure due to the efficiencies gained from technology. The services-providing industries found in STEM Core require fewer physical inputs from other local employers and therefore have a smaller multiplier effect. Even so, a multiplier effect of 1.3 for this group is significant as these industries are projected to continue growing.

Tech Wage Premium

Another method of analysis for assessing the impact of tech jobs on the Vermont economy used the REMI input-output model to quantify the impact of the wage premium associated with tech jobs. A wage premium is the difference in mean wages from two industries or occupations. In this case, the wage premium was the difference in mean annual wage of tech occupations and the mean annual wage of all Vermont occupations. This wage premium for all tech occupations was $28,192 per position. The difference allowed us to observe the economic impact of the additional capital (and therefore expenditures) in the economy produced by the wage premium. It also allowed us to gauge an estimate of the change in employment incurred by this wage premium.

The outcome of the wage premium analysis showed that by removing the premium from the economy, there was decline in the Vermont GDP of roughly $280 million or 0.9% and an employment decline of 4,600 jobs, or 1.5%. In other words, the wage premium of tech jobs adds an additional $280 million and supports approximately 4,600 jobs via induced effects in the Vermont economy.

Location Quotients

Location quotients (LQ) are ratios used to understand and compare industries in different places. Here, LQs are used to understand how Vermont compares to the United States with tech industry employment. A LQ of one depicts the employment of the measured industry within the area of study (Vermont) as having the same share of employment as the referenced region (U.S.). Anything below one denotes a lower relative concentration of employment and greater than one indicates a higher relative share of employment. LQs are frequently used by economic development professionals as they attempt to assess regional strengths (LQs above 1; indicating potentially export industries) and underrepresented industries (LQs below 1 indicating goods or services whose local demand is potentially being met by imports from out of the region of study).

Table 4 illustrates the highest five and the lowest five LQ's for STEM Core and STEM Health (the full list can be seen in Appendix 3). STEM Health displays four industries with LQs larger than one out of 13[3], while STEM Core has seven LQs over one out of 33[4]. Interestingly enough, the two LQs in STEM Core with a LQ of 2 or more are goods-producing industries that are projected to shrink. On the low end of the LQ list, numerous industries are underrepresented in Vermont. STEM Core has ten industries with a LQ of less than or equal to .5 while STEM Health has one industry below that level.

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[3] Of the 13 STEM Health industries, 2 were not disclosable.

[4] Of the 33 STEM Core industries, 6 were not disclosable and 3 had no available information.

Table 4

STEM Core (2014)		
5 Largest Location Quotients for Vermont		
333200	Industrial Machinery Manufacturing	2.91
333300	Commercial and Service Industry Machinery Manufacturing	2.00
221100	Electric Power Generation, Transmission and Distribution	1.84
334500	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1.68
424200	Drugs and Druggists' Sundries Merchant Wholesalers	1.55
5 Smallest Location Quotients for Vermont		
334100	Computer and Peripheral Equipment Manufacturing	0.15
325100	Basic Chemical Manufacturing	0.16
335300	Electrical Equipment Manufacturing	0.22
324100	Petroleum and Coal Products Manufacturing	0.25
517200	Wireless Telecommunications Carriers (except Satellite)	0.25

STEM Health (2014)		
5 Largest Location Quotients for Vermont		
621400	Outpatient Care Centers	2.98
622100	General Medical and Surgical Hospitals	1.29
621300	Offices of Other Health Practitioners	1.25
623100	Nursing Care Facilities (Skilled Nursing Facilities)	1.07
621200	Offices of Dentists	0.97
5 Smallest Location Quotients for Vermont		
621500	Medical and Diagnostic Laboratories	0.23
621600	Home Health Care Services	0.82
541900	Other Professional, Scientific, and Technical Services	0.88
621100	Offices of Physicians	0.90
446100	Health and Personal Care Stores	0.91

Conclusion

The presence of tech has been and will continue to be an integral part of Vermont's economy. The total of tech workers in tech industries, tech workers in non-tech industries and non-tech workers in tech industries is 74,101 or 24.3% of the total Vermont workforce. The impact of these workers on the Vermont economy is even larger when considering that the average wage for tech occupations is $72,732; $28,192 higher than the mean wage for all Vermont occupations. Furthermore, other studies cite multiplier effects that highlight how other jobs in the economy rely on a particular sector an our preliminary use of the REMI model also shows their importance to the state. Because the tech industry is so large in Vermont, the multiplier confirms that a majority of jobs in Vermont have a link to the tech sector. Not only is tech a large part of the Vermont economy, but it is growing. Between 2005 and 2014, there was an average annual rate of change of 0.9%. During this same period, overall Vermont employment grew by an annual average of 0.1%. Today, tech employment makes up nearly a quarter of total Vermont employment.

Appendix 1

VERMONT DEPARTMENT OF LABOR

Tech Industry and Tech Occupation Lists

Tech Industry List (2.5x concentration or greater)

STEM Core Industries

211100	Oil and Gas Extraction
221100	Electric Power Generation, Transmission and Distribution
324100	Petroleum and Coal Products Manufacturing
325100	Basic Chemical Manufacturing
325200	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
325400	Pharmaceutical and Medicine Manufacturing
333200	Industrial Machinery Manufacturing
333300	Commercial and Service Industry Machinery Manufacturing
333600	Engine, Turbine, and Power Transmission Equipment Manufacturing
334100	Computer and Peripheral Equipment Manufacturing
334200	Communications Equipment Manufacturing
334300	Audio and Video Equipment Manufacturing
334400	Semiconductor and Other Electronic Component Manufacturing
334500	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
335300	Electrical Equipment Manufacturing
336400	Aerospace Product and Parts Manufacturing
423400	Professional and Commercial Equipment and Supplies Merchant Wholesalers
423600	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers
424200	Drugs and Druggists' Sundries Merchant Wholesalers
486100	Pipeline Transportation of Crude Oil
511200	Software Publishers
517100	Wired Telecommunications Carriers
517200	Wireless Telecommunications Carriers (except Satellite)
517900	Other Telecommunications
518200	Data Processing, Hosting, and Related Services
519100	Other Information Services
521100	Monetary Authorities-Central Bank
541300	Architectural, Engineering, and Related Services
541500	Computer Systems Design and Related Services
541600	Management, Scientific, and Technical Consulting Services
541700	Scientific Research and Development Services
551100	Management of Companies and Enterprises
999100	Federal Government

<u>STEM Health Industries</u>

446100	Health and Personal Care Stores
541900	Other Professional, Scientific, and Technical Services
621100	Offices of Physicians
621200	Offices of Dentists
621300	Offices of Other Health Practitioners
621400	Outpatient Care Centers
621500	Medical and Diagnostic Laboratories
621600	Home Health Care Services
621900	Other Ambulatory Health Care Services
622100	General Medical and Surgical Hospitals
622200	Psychiatric and Substance Abuse Hospitals
622300	Specialty (except Psychiatric and Substance Abuse) Hospitals
623100	Nursing Care Facilities (Skilled Nursing Facilities)

Tech Occupation List

STEM Core Occupations

SOC Code	Occupation Label
11-3021	Computer and Information Systems Managers
11-9041	Architecture and Engineering Managers
11-9121	Natural Science Managers
15-1111	Computer and Information Research Scientists
15-1121	Computer Systems Analysts
15-1122	Information Security Analysts
15-1131	Computer Programmers
15-1132	Software Developers, Applications
15-1133	Software Developers, Systems Software
15-1134	Web Developers
15-1141	Database Administrators
15-1142	Network and Computer Systems Administrators
15-1143	Computer Network Architects
15-1151	Computer User Support Specialists
15-1152	Computer Network Support Specialists
15-1199	Computer Occupations, All Other
15-2011	Actuaries
15-2021	Mathematicians
15-2031	Operations Research Analysts
15-2041	Statisticians
15-2091	Mathematical Technicians
15-2099	Mathematical Science Occupations, All other
17-1021	Cartographers and Photogrammetrists
17-1022	Surveyors
17-2011	Aerospace Engineers
17-2021	Agricultural Engineers
17-2031	Biomedical Engineers
17-2041	Chemical Engineers
17-2051	Civil Engineers
17-2061	Computer Hardware Engineers
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-2081	Environmental Engineers
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors
17-2112	Industrial Engineers
17-2121	Marine Engineers and Naval Architects
17-2131	Materials Engineers

17-2141	Mechanical Engineers
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers
17-2161	Nuclear Engineers
17-2171	Petroleum Engineers
17-2199	Engineers, All other
17-3011	Architectural and Civil Drafters
17-3012	Electrical and Electronics Drafters
17-3013	Mechanical Drafters
17-3019	Drafters, All other
17-3021	Aerospace Engineering and Operations Technicians
17-3022	Civil Engineering Technicians
17-3023	Electrical and Electronics Engineering Technicians
17-3024	Electro-Mechanical Technicians
17-3025	Environmental Engineering Technicians
17-3026	Industrial Engineering Technicians
17-3027	Mechanical Engineering Technicians
17-3029	Engineering Technicians, Except Drafters, All other
17-3031	Surveying and Mapping Technicians
19-1011	Animal Scientists
19-1012	Food Scientists and Technologists
19-1013	Soil and Plant Scientists
19-1021	Biochemists and Biophysicists
19-1022	Microbiologists
19-1023	Zoologists and Wildlife Biologists
19-1029	Biological Scientists, All other
19-1031	Conservation Scientists
19-1032	Foresters
19-1041	Epidemiologists
19-1042	Medical Scientists, Except Epidemiologists
19-1099	Life Scientists, All other
19-2011	Astronomers
19-2012	Physicists
19-2021	Atmospheric and Space Scientists
19-2031	Chemists
19-2032	Materials Scientists
19-2041	Environmental Scientists and Specialists, Including Health
19-2042	Geoscientists, Except Hydrologists and Geographers
19-2043	Hydrologists
19-2099	Physical Scientists, All other
19-4011	Agricultural and Food Science Technicians
19-4021	Biological Technicians
19-4031	Chemical Technicians
19-4041	Geological and Petroleum Technicians

19-4051	Nuclear Technicians
19-4091	Environmental Science and Protection Technicians, Including Health
19-4092	Forensic Science Technicians
19-4093	Forest and Conservation Technicians
19-4099	Life, Physical, and Social Science Technicians, All other
25-1021	Computer Science Teachers, Postsecondary
25-1022	Mathematical Science Teachers, Postsecondary
25-1032	Engineering Teachers, Postsecondary
25-1041	Agricultural Sciences Teachers, Postsecondary
25-1042	Biological Scientists, All other
25-1043	Forestry and Conservation Science Teachers, Postsecondary
25-1051	Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary
25-1052	Chemistry Teachers, Postsecondary
25-1053	Environmental Science teachers, Postsecondary
25-1054	Physics Teachers, Postsecondary
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
41-9031	Sales Engineers

STEM Health Occupations

SOC Code	**Occupation Label**
11-9111	Medical and Health Services Managers
25-1071	Health Specialties Teachers, Postsecondary
25-1072	Nursing Instructors and Teachers, Postsecondary
29-1011	Chiropractors
29-1021	Dentists, General
29-1022	Oral and Maxillofacial Surgeons
29-1023	Orthodontists
29-1024	Prosthodontists
29-1029	Dentists, All other specialists
29-1031	Dietitians and Nutritionists
29-1041	Optometrists
29-1051	Pharmacists
29-1061	Anesthesiologists
29-1062	Family and General Practitioners
29-1063	Internists, General
29-1064	Obstetricians and Gynecologists
29-1065	Pediatricians, General
29-1066	Psychiatrists
29-1067	Surgeons
29-1069	Physicians and Surgeons, All other
29-1071	Physician Assistants

29-1081 Podiatrists
29-1122 Occupational Therapists
29-1123 Physical Therapists
29-1124 Radiation Therapists
29-1125 Recreational Therapists
29-1126 Respiratory Therapists
29-1127 Speech-Language Pathologists
29-1128 Exercise Physiologists
29-1129 Therapists, All Other
29-1131 Veterinarians
29-1141 Registered Nurses
29-1151 Nurse Anesthetists
29-1161 Nurse Midwives
29-1171 Nurse Practitioners
29-1181 Audiologists
29-1199 Health Diagnosing and Treating Practitioners, All Other
29-2011 Medical and Clinical Laboratory Technologists
29-2012 Medical and Clinical Laboratory Technicians
29-2021 Dental Hygienists
29-2031 Cardiovascular Technologists and Technicians
29-2032 Diagnostic Medical Sonographers
29-2033 Nuclear Medicine Technologists
29-2034 Radiologic Technicians
29-2035 Magnetic Resonance Imaging Technologists
29-2041 Emergency Medical Technicians and Paramedics
29-2051 Dietetic Technicians
29-2052 Pharmacy Technicians
29-2053 Psychiatric Technicians
29-2054 Respiratory Therapy Technicians
29-2055 Surgical Technologists
29-2056 Veterinary Technologists and Technicians
29-2057 Ophthalmic Medical Technicians
29-2061 Licensed Practical and Licensed Vocational Nurses
29-2071 Medical Records and Health Information Technicians
29-2081 Opticians, Dispensing
29-2091 Orthotists and Prosthetists
29-2092 Hearing Aid Specialists
29-2099 Health Technologists and Technicians, All Other
29-9011 Occupational Health and Safety Specialists
29-9012 Occupational Health and Safety Technicians
29-9091 Athletic Trainers
29-9092 Genetic Counselors
29-9099 Healthcare Practitioners and Technical Workers, All other

Appendix 2

Goods-Producing and Services-Providing Tech Industries

Goods-Producing

STEM Core

211100	Oil and Gas Extraction
221100	Electric Power Generation, Transmission and Distribution
324100	Petroleum and Coal Products Manufacturing
325100	Basic Chemical Manufacturing
325200	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
325400	Pharmaceutical and Medicine Manufacturing
333200	Industrial Machinery Manufacturing
333300	Commercial and Service Industry Machinery Manufacturing
333600	Engine, Turbine, and Power Transmission Equipment Manufacturing
334100	Computer and Peripheral Equipment Manufacturing
334200	Communications Equipment Manufacturing
334300	Audio and Video Equipment Manufacturing
334400	Semiconductor and Other Electronic Component Manufacturing
334500	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
335300	Electrical Equipment Manufacturing
336400	Aerospace Product and Parts Manufacturing

Services-Providing

STEM Core

423400	Professional and Commercial Equipment and Supplies Merchant Wholesalers
423600	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers
424200	Drugs and Druggists' Sundries Merchant Wholesalers
486100	Pipeline Transportation of Crude Oil
511200	Software Publishers
517100	Wired Telecommunications Carriers
517200	Wireless Telecommunications Carriers (except Satellite)
517900	Other Telecommunications
518200	Data Processing, Hosting, and Related Services
519100	Other Information Services
521100	Monetary Authorities-Central Bank
541300	Architectural, Engineering, and Related Services
541500	Computer Systems Design and Related Services
541600	Management, Scientific, and Technical Consulting Services
541700	Scientific Research and Development Services
551100	Management of Companies and Enterprises

STEM Health

446100	Health and Personal Care Stores
541900	Other Professional, Scientific, and Technical Services
621100	Offices of Physicians
621200	Offices of Dentists
621300	Offices of Other Health Practitioners
621400	Outpatient Care Centers
621500	Medical and Diagnostic Laboratories
621600	Home Health Care Services
621900	Other Ambulatory Health Care Services
622100	General Medical and Surgical Hospitals
622200	Psychiatric and Substance Abuse Hospitals
622300	Specialty (except Psychiatric and Substance Abuse) Hospitals
623100	Nursing Care Facilities (Skilled Nursing Facilities)

**Note*: 9991, Federal government has been removed from this list.

Appendix 3

Tech Industry Location Quotients

STEM Core

NAICS Code	Industry Title	LQ
211100	Oil and Gas Extraction	NC
221100	Electric Power Generation, Transmission and Distribution	1.84
324100	Petroleum and Coal Products Manufacturing	0.25
325100	Basic Chemical Manufacturing	0.16
325200	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	0.51
325400	Pharmaceutical and Medicine Manufacturing	1.04
333200	Industrial Machinery Manufacturing	2.91
333300	Commercial and Service Industry Machinery Manufacturing	2.00
333600	Engine, Turbine, and Power Transmission Equipment Manufacturing	ND
334100	Computer and Peripheral Equipment Manufacturing	0.15
334200	Communications Equipment Manufacturing	ND
334300	Audio and Video Equipment Manufacturing	ND
334400	Semiconductor and Other Electronic Component Manufacturing	ND
334500	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1.68
335300	Electrical Equipment Manufacturing	0.22
336400	Aerospace Product and Parts Manufacturing	1.25
423400	Professional and Commercial Equipment and Supplies Merchant Wholesalers	0.42
423600	Household Appliances and Electrical and Electronic Goods Merchant Wholesalers	0.49
424200	Drugs and Druggists' Sundries Merchant Wholesalers	1.55
486100	Pipeline Transportation of Crude Oil	ND
511200	Software Publishers	0.91
517100	Wired Telecommunications Carriers	0.83
517200	Wireless Telecommunications Carriers (except Satellite)	0.25
517900	Other Telecommunications	ND
518200	Data Processing, Hosting, and Related Services	0.37
519100	Other Information Services	0.96
521100	Monetary Authorities-Central Bank	NC
541300	Architectural, Engineering, and Related Services	0.73
541500	Computer Systems Design and Related Services	0.94
541600	Management, Scientific, and Technical Consulting Services	0.76
541700	Scientific Research and Development Services	0.25
551100	Management of Companies and Enterprises	0.44
999100	Federal Government	NC

STEM Health

446100	Health and Personal Care Stores	0.91
541900	Other Professional, Scientific, and Technical Services	0.88
621100	Offices of Physicians	0.90
621200	Offices of Dentists	0.97
621300	Offices of Other Health Practitioners	1.25
621400	Outpatient Care Centers	2.98
621500	Medical and Diagnostic Laboratories	0.23
621600	Home Health Care Services	0.82
621900	Other Ambulatory Health Care Services	0.94
622100	General Medical and Surgical Hospitals	1.29
622200	Psychiatric and Substance Abuse Hospitals	ND
622300	Specialty (except Psychiatric and Substance Abuse) Hospitals	ND
623100	Nursing Care Facilities (Skilled Nursing Facilities)	1.07

Appendix 4

Review of Relevant Literature

There are several overarching themes that appear within studies of tech. Though each study yields different results, the ways of approaching the problem are very similar. On the issue of tech industry taxonomies, several studies employed the measurement of tech occupation concentrations within each industry, using multiples of the national tech concentration average as the base threshold for industries qualifying as tech. Furthermore, each study chose a list of occupations that they deemed tech based on their own definition or to fit the specifications of their study.

Federal Efforts

Standard Occupation Classification (SOC) Policy Committee

According to the SOC Policy Committee (2012), high-tech jobs commonly require Science, Technology, Engineering, or Mathematics (STEM) degrees. While STEM degrees are categorized based on their field of study, STEM occupations are much harder to discern. Recognizing this shortcoming, in 2010 the SOC Policy Committee made a recommendation to the Office of Management and Budget (OMB) to classify STEM occupations within 2 major occupational domains (1-2) as well as 4 sub-domains (a-d) listed below:

1. <u>Science, Engineering, Mathematics, and Information Technology Domain</u>
    - a.) Life and Physical Science, Engineering Mathematics, and Information Technology Occupations
    - b.) Social Science Occupations
2. <u>Science- and Engineering-Related Domain</u>
    - c.) Architecture Occupations
    - d.) Health Occupations

Additionally, within each of these 4 Sub-Domains (a-d), 5 types of STEM occupations were identified:

- A. Research, Development, Design, or Practitioner Occupations
- B. Technologist and Technician Occupations
- C. Postsecondary Teaching Occupations
- D. Managerial Occupations
- E. Sales Occupations

It is important to note that within these subdomains, not all industries are STEM. For example, only certain Social Science Occupations are considered STEM, while others are not.
(SOC, 2012, pg. 2)

Bureau of Labor Statistics

In "High-technology employment: a NAICS-based update," (2005) Daniel Hecker of the BLS examines and defines tech employment. Hecker's study has subsequently been referenced by numerous other studies. Hecker identifies an industry as tech by looking at the concentration of tech occupations within a given industry. To do this he defines tech occupations as scientific, engineering, and technician occupations, also stating that workers in these fields need an in depth knowledge of science, engineering, and mathematical theories and principles (Hecker, 2005, pg. 58). These occupations often require educational training that ranges from an advanced certificate through a doctoral degree. Occupations that fit Hecker's definition for tech are those, "…engaged in R&D, increasing scientific knowledge and using it to develop products and production processes; others apply technology in other activities, including the design of equipment, processes, and structures; computer applications; sales, purchasing, and marketing; quality management; and the management of these activities," (Hecker, 2005, pg.58).

Hecker defines industries as tech if they have a concentration of tech occupations at least twice the national average tech occupation concentration. Through this analysis, Hecker produced a list of 46 four-digit NAICS industries fitting the criteria. These 46 industries are broken down further into three separate levels. Level-I represented the 14 industries where tech occupations accounted for at least 5 times the national average for tech occupations. Level-II included 12 industries where occupations were 3 to 4.9 times the national average. And Level-III represented the remaining industries where occupations were 2 to 2.9 times the national average (Hecker, 2005).
State Research

Workforce Information Council & Idaho

In 2014, the Workforce Information Council (WIC) and the State of Idaho published a report titled "Exploring the High-Tech Industry." This study adopted Daniel Hecker's model from his 2005 paper but amended his methods slightly. The WIC/Idaho study used a list of the four STEM sub-domains produced by the SOC Policy Committee. Within the four STEM sub-domains, the authors decided to focus on two: Domain 1 which included Life and Physical Sciences, Engineering, Mathematics, and Information Technology; and Domain 4 which included health occupations. The authors used these two occupational classifications to observe STEM occupation concentrations within the NAICS industry categories (Idaho, 2014). The authors describe the chosen subdomains as "the strongest, most comprehensive description of high-tech occupations," (WIC, 2014, pg. 28). The authors conclude that a threshold of 2.5 times the all-industry average for tech occupation concentrations was adequate in helping to discern tech industries. As a result, the model under this precondition identified 46 four-digit NAICS industries as tech (WIC, 2014).

This study cites data from the Quarterly Census of Employment and Wages (QCEW) and the Quarterly Workforce Indicators (QWI).

Private Research

Carnegie Mellon

In the article, "Technology Industries and Occupation for NAICS Industry Data" (2004), published by Carnegie Mellon's Center for Economic Development, the authors supplemented their own research methods with that of other studies. The authors utilized a list of 38 tech occupations for their study produced by Chapple et al. explaining that this particular study, "identified a set of occupations…[that were] science and engineering intensive," (Paytas & Berglund, 2004, pg. 3; Chapple et al, 2004).

Industries were deemed tech if their employment of tech occupations exceeded three times the national average of 3.33%, or 9.99%. (Paytas & Berglund, 2004). Over the course of their analysis, Carnegie Mellon produced a list of 81 tech industries at the four and six-digit level that met the occupation concentration requirement.

From the 81 tech industries mentioned above, a list of Primary and Secondary Technology generators was defined to measure the strength of tech within these given industries. Industries are Primary Technology Generators, "if they exceed the U.S. average for both research and development expenditures per employee ($11,297.00) and for the proportion of full-time-equivalent R&D scientists and engineers in the industry workforce (5.9%)," (Paytas & Berglund, 2004, pg. 3). Secondary Technology Generators, on the other hand, are industries that meet only one of these criteria. 49 of these industries were categorized as Primary Technology Generators while only 21 were considered Secondary Technology Generators. The 11 that were excluded employ tech but do not facilitate the creation of it.

Chapple et al.

In the article, "Gauging Metropolitan "High-Tech" and "I-Tech" Activity," the authors amend the methods of earlier studies to fit the purposes of their own. Their categorization of tech occupations were human capital oriented – that is, they reflect an interest in skilled labor, rather than resources or capital used (Chapple et al, 2004).

Unlike other studies, the authors opted not to experiment with the sensitivity of industries to different thresholds, such as 15%, nearly five times the national average at the time (Chapple et al., 2004). That being said, the authors expressed that in the future it would be interesting to experiment with different cutoff points (Chapple et al., 2004). There are, however, other ways of analyzing the resilience of certain emerging and traditional tech industries. For instance, looking at the growth of these industries during the recession would be an indicator as to their strength, while other firms are laying off workers these industries are providing employment for laid-off science and technology (S&T) workers (Chapple et al., 2004).

CompTIA – Cyberstates

CompTIA provides a comprehensive analysis of the U.S. tech industry in their 2015 report entitled, "Cyberstates 2015: The definitive state-by-state analysis of the U.S. tech industry." Instead of using occupations concentrations to define tech industries, this report defines industries as tech based on their attributes and characteristics. Based on the NAICS, this study created five major industry groups as tech: tech manufacturing, telecommunications and internet service, software publishing, IT services, and R&D, testing, and engineering services. Industries fitting these parameters of tech participated in the, "making, creating, enabling, integrating, or supporting tech as a product or service," (CompTIA, 2015, p.116).

Cyberstates used data from the BLS and a number of independent organizations to create a state-by-state analysis of tech in the U.S. Using a combination of estimation and resources provided by these organizations, the authors were able to build a comprehensive model of each state and its current tech standing.

The New York City Tech Ecosystem

The authors of the study, "The New York City Tech Ecosystem, Generating Economic Opportunities for All New Yorkers," adopt a broad-sweeping analysis of tech industries in New York. While this study does not specifically outline its definition of tech, it explains that tech occupations, "produce, facilitate, or exist because of technology," (HR & A Advisors, 2015, pg. 21). For this reason, the authors felt in observing the wide-ranging presence of tech, its reach warranted the name "tech ecosystem." Jobs within this tech ecosystem fall into three categories: 1) tech jobs in tech industries, 2) non-tech jobs in tech industries and 3) tech jobs in non-tech industries (HR & A Advisors, 2015, pg. 22). In addition to creating a definition of tech this study also sought to measure and include self-employment in its analysis. Because traditionally used employment measures (QCEW, OES) do not accurately capture self-employment and self-employment is often prevalent in tech related fields, the inclusion of it portrays a better picture of tech.

The authors produced a list of some 15 industries whose tech and non-tech jobs help comprise the "tech ecosystem." In addition, the authors produced a list of 48 tech occupations prevalent across tech and non-tech industries. The breadth of this project is certainly comprehensive and is a model that demonstrates the extensive presence of tech jobs within and without tech and non-tech industries.

Summary of Literature

Existing case studies and reports have exhibited different methods to define and analyze the impact of tech at a national and state level. The Hecker and Chapple articles were both cited by other studies and seemed to provide a precedent used by many others. These two articles both defined industries as high-tech through an occupation concentration.

All studies referenced chose to define occupations as tech on a case-by-case basis. Because each study independently determined the tech component of each occupation, the lists of occupations vary widely depending on the report. An example of this can be seen between Hecker's study and the Idaho study. The Idaho study included in its data set a number of occupations such as dental hygienist, MRI technologists, orthotists, prosthetists, and others. These occupations and a number of other healthcare occupations included in the Idaho study – by SOC's occupational description – neither research nor design, develop, or engage in innovative manufacturing processes using scientific and technical knowledge (Hecker, 2005, pg. 57). Hecker argues that in order for a job to be considered tech it must meet the aforementioned criteria. The Idaho study, on the other hand, sought a broader definition of tech to use in their analysis. Because Idaho, however, used for its study both STEM Health and STEM Core occupations, it was determined that their list of occupations would best represent the scope of tech within Vermont.

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