The Retention of Graduates from Engineering Education Expansion in Kansas

Roy Myose, L. Scott Miller, Steven Skinner,
College of Engineering, Wichita State University, Wichita, KS 67260-0044
and James Myose
College of Arts & Sciences, Kansas State University, Manhattan, KS 66506

Introduction

In today's increasingly technological world, nations and states must increase the number of workers with the appropriate Science, Technology, Engineering, and Math (STEM) skills that are necessary to remain competitive. This viewpoint is confirmed by, "a number of studies [that] have shown that 50 to 85 percent of the growth in America's GDP is attributable to advancements in Science and Engineering."[1] As another example of the need for more workers with STEM skills, the state of Delaware's STEM Council found that "for every unemployed person in Delaware, there are 3.8 open jobs in STEM fields, and for every non-STEM job there are 1.7 people in the state."[2] According to a report from Georgetown University, "STEM occupations [in the United States] will grow far more quickly than the economy as a whole."[2] In order to address this need for more workers with STEM skills, many states have increased their spending on STEM-related degree programs. In the state of Kansas, an Engineering initiative in 2011 added 10½ million dollars per year to the three state universities with Engineering programs (i.e., 3½ million dollars per year to each university) in order to increase Engineering graduation numbers by about 60% over ten years.[3]

The goal of the Kansas initiative is to add 164 Engineering bachelor's graduates to each university by 2021. Since the funding amount to each university is the same, establishing a goal with the same increase is reasonable. It should be noted, however, that the baseline graduation numbers (i.e., established to be from 2008) are quite different for each university – 423 for Kansas State University (K-State), 255 for University of Kansas (KU), and 197 for Wichita State University (WSU). This means that the percentage increase for each university is quite different – 39% increase for K-State, 64% increase for KU, and 83% increase for WSU. Information about the progress made by the three universities thus far is available from the Kansas Board of Regents (KBOR). Table 1[4] provides the number of Engineering bachelor's graduate numbers after seven years (2012 to 2018) while the increase from the baseline is given in parenthesis.

Table 1 – Engineering Graduation Numbers in Kansas (Increase in Parentheses)

School	Baseline	2012	2013	2014	2015	2016	2017	2018	Goal
K-State	423	480 (+57)	471 (+48)	529 (+106)	498 (+75)	494 (+71)	609 (+186)	694 (+271)	587 (+164)
KU	255	335 (+80)	338 (+83)	367 (+112)	400 (+145)	499 (+244)	435 (+180)	526 (+271)	419 (+164)
WSU	197	214 (+17)	208 (+11)	238 (+41)	267 (+70)	292 (+95)	304 (+107)	345 (+148)	361 (+164)

The results in Table 1 show that KU reached its goal in 2016 while K-State reached its goal in 2017. At the same time, WSU is well on its way to reach its goal by 2021 and has increased its graduation numbers by 75% compared to its baseline. This paper is motivated by a desire to see if there are other important metrics to consider, such as the retention of Engineering graduates in the state of Kansas.

In order to answer the question, "how much do college graduates add to the state's economy," four researchers from West Virginia University[5] conducted a sophisticated economic analysis by first considering the additional income earned during their career by highly educated graduates employed in the state. Next, they determined the multiplier due to "demand-side effect" of additional spending from purchasing goods and services in the state as well as "supply-side effect" of additional

productivity from companies in the state employing these college educated graduates (compared to high school graduates). As Engineering Educators and an Economics undergraduate student, it is outside the scope of our capabilities to determine the "value-added" and the resulting multiplier effect. However, KBOR already has some information available for some of the basic initial steps associated with making an economic estimate as will be shown below.

In another example of economic analysis, the Mid-America Regional Council[6] conducted a study to determine the engineering, architectural, and construction services' economic impact and future labor needs for the Kansas City area. They estimated that about one-third of all exports to other parts of the country as well as internationally (about $26 billion out of the $76 billion total in 2017) were due to architectural, engineering, manufacturing, and scientific service (i.e., STEM-related) industries. They next determined the labor demands in those occupational areas over the next ten years based on Bureau of Labor Statistics (BLS) data. Although it may not be possible to determine the labor demands to the level of detail performed by the Mid-America Regional Council, the current paper will present some first order estimates of labor demand for engineers using BLS data.

There are two different analyses that are considered in this paper. First, we consider the number of Engineering graduates employed in Kansas and their entry-level wages. This then provides a measure that more directly relates to their contribution to the state of Kansas. As a part of the second analysis, we consider individual majors rather than Engineering considered as a whole. KBOR has data associated with Engineering graduate employment in Kansas as well as some limited information for individual majors. Finally, future labor demand estimates are made based on BLS data. In the following sections, the methodology used is explained, and then results are presented and discussed.

Impact from Each Engineering College, Considered as a Whole

KBOR[4] provides information about the number of bachelor's Engineering graduates employed in Kansas and their entry-level wages – they are presented in Table 2. The table shows that K-State, KU, and WSU have varying impacts in terms of the number of Engineering graduates employed in Kansas. The right-hand columns of Table 2 show that K-State had the most and KU had the fewest in terms of annual number of Engineering graduates employed in Kansas in terms of raw numbers as well as a proportional between the three universities.

Table 2 – Number of Engineering Graduates Employed in Kansas and Their Starting Wages

School	2012	2013	2014	2015	2016	2017	2018	7-yr Ave	Proportion
K-State	219	193	225	221	203	230	288	226	43%
KU	133	122	115	156	180	147	176	145	27%
WSU	149	131	145	154	162	165	184	156	29%
K-State	$48,314	$48,065	$51,545	$55,310	$50,563	$49,879	$53,122		
KU	$45,883	$46,510	$50,548	$47,741	$46,603	$46,951	$49,082		
WSU	$44,216	$45,334	$44,623	$49,043	$49,307	$45,053	$49,353		

A better perspective on the direct impact of the Engineering education initiative is to determine the additional number of Engineering graduates that are employed in Kansas compared to a baseline. Although the baseline number for all Engineering graduates is known, the number of graduates employed in Kansas from each university is not known for the baseline year of 2008. An alternative way of measuring the direct impact on the state of Kansas, absent this baseline information, is to consider what percentage of the Engineering graduates is employed in Kansas. This is obtained by simply dividing the number of graduates employed in Kansas given in Table 2 by the number of graduates in Table 1. The annual results are presented in Table 3 along with the 7-year average for each university in the right-most column and the weighted average of combining all three universities for each year in the bottom row. A graphical version of these results is shown in Figure 1.

Table 3 – Percentage of Engineering Graduates Employed in Kansas

School	2012	2013	2014	2015	2016	2017	2018	7-yr Ave
K-State	45.6%	41.0%	42.5%	44.4%	41.1%	37.8%	41.5%	42.0%
KU	39.7%	36.1%	31.3%	39.0%	36.1%	33.8%	33.5%	35.6%
WSU	69.6%	63.0%	60.9%	57.7%	55.5%	54.3%	53.3%	59.2%
Weighted Average	48.7%	43.9%	42.8%	45.6%	42.4%	40.2%	41.4%	43.6%

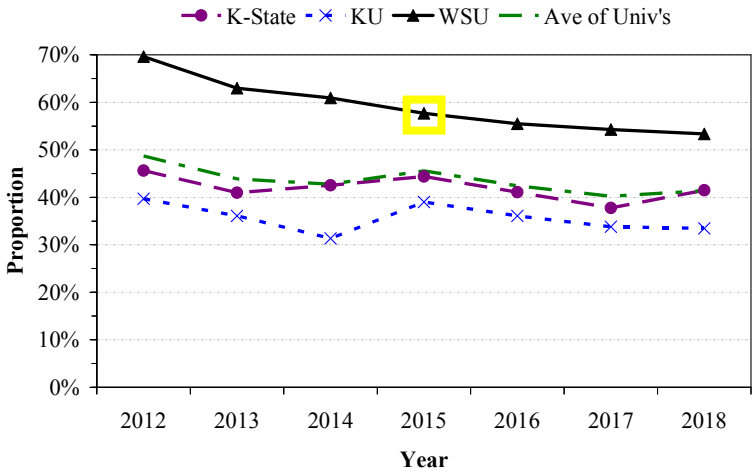

Figure 1 – Percentage of Engineering graduates employed in Kansas.

A couple of salient features are evident in the results given in Table 3. First, a significant fraction of WSU Engineering graduates (~60%) are employed in Kansas as shown in the 7-year average as well as the year-by-year results. K-State's average of 42% is close to the overall average of 43.6% while KU's is less than the average. This suggests that WSU provides better "bang for the buck" to the state, leading to a higher proportion of their graduates working in Kansas compared to the other two universities. The purpose of the state legislature funding this Engineering education initiative was to increase the number of Engineering graduates staying and working in Kansas rather than exporting the majority out-of-state. The results from Table 3 show that WSU does a better job of producing Engineering graduates who stay in Kansas, proportionally speaking.

The second observation is that there was a change in the percentage of the graduates staying and working in Kansas after about 2015. For WSU, more than 60% of their graduates stayed in Kansas before 2015 while they were in the mid- to lower 50%'s after 2015. Somewhat similar trends can be seen for K-State (typically above the 42% average value vs. below average), KU (upper 30%'s vs. lower 30%'s), and the overall results for the three universities (upper 40%'s vs. lower 40%'s). Such a trend suggests that something was happening overall in the Kansas economy from about 2015.

In order to see what the economic trends were in Kansas compared to the country as a whole, the unemployment rate and the non-farm labor force numbers were considered. Both sets of data originate from the BLS, but are presented in easily accessible format by the Federal Reserve Bank of St. Louis. Figure 2 shows the unemployment rate in the U.S.[7a] and in Kansas[7b] from January 2001 to April 2019. The time period chosen for the figure shows two recessionary periods – the "Dot-com Bust" of 2001 which led to an increase in the unemployment rate in the U.S. by about 50% (from ~4% to ~6%) while the Great Recession of 2008 led to a doubling of the unemployment rate in the U.S. (from ~5% to ~10%). It appears that the ensuing recovery after the Great Recession has come in at least two phases so far. In the first phase from early 2010 until late 2014, there appears to be a relatively sharp recovery with a steep *negative* slope for both the country as a whole (slope of -0.00231) as well as for Kansas (-0.00128). During the second phase from early 2015 until recently, the slope has become shallower for both the entire country (slope of -0.00180) as well as for Kansas (-0.00087). As can be seen by the

green lines in Figure 3, the slope is much shallower for Kansas compared to the country as a whole for this period. On the other hand, the increase in unemployment rate right after the Great Recession appears to have been milder for Kansas (peak of 7.9%) compared to the entire country (peak of 10%). Thus, more graduates may have stayed in Kansas during the first phase of the recovery while Kansas graduates may have found better opportunities elsewhere during the second phase of the recovery.

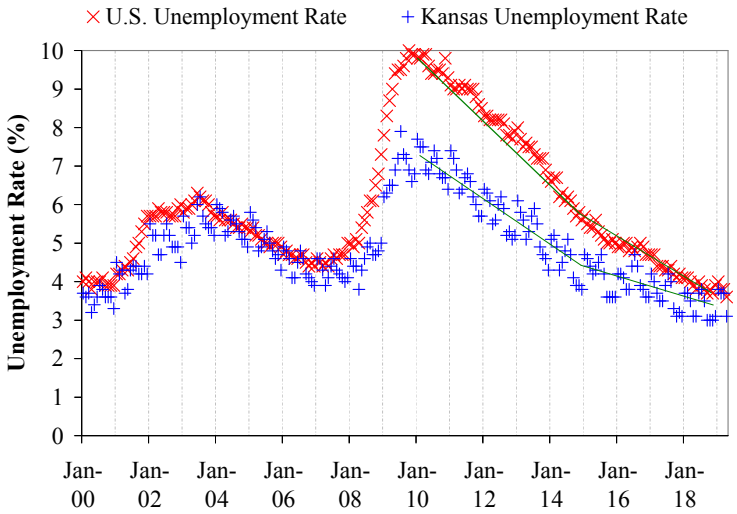

Figure 2 – Month-to-month unemployment rate in the United States and in Kansas.

Another economic trend to consider is the number of non-farm laborers employed in the U.S.[7c] and in Kansas[7d]. This is presented in the top line of each row in Table 4 while the bottom line of each row and Figure 3 present the change from year to year in percentage terms. The idea of considering change in employment numbers per year comes from an economic report[8] of the Kansas Department of Labor

Table 4 – Non-farm Labor Employee Numbers (Seasonally Adjusted) [in millions] and Change Compared to Previous Year (in Parentheses)

	2012	2013	2014	2015	2016	2017	2018
United States	134.17 (+1.7%)	136.37 (+1.6%)	138.94 (+1.9%)	141.83 (+2.1%)	144.35 (+1.8%)	146.61 (+1.6%)	149.06 (+1.7%)
Kansas	1.357 (+1.3%)	1.372 (+1.1%)	1.391 (+1.4%)	1.400 (+0.7%)	1.405 (+0.3%)	1.404 (-0.1%)	1.416 (+0.9%)

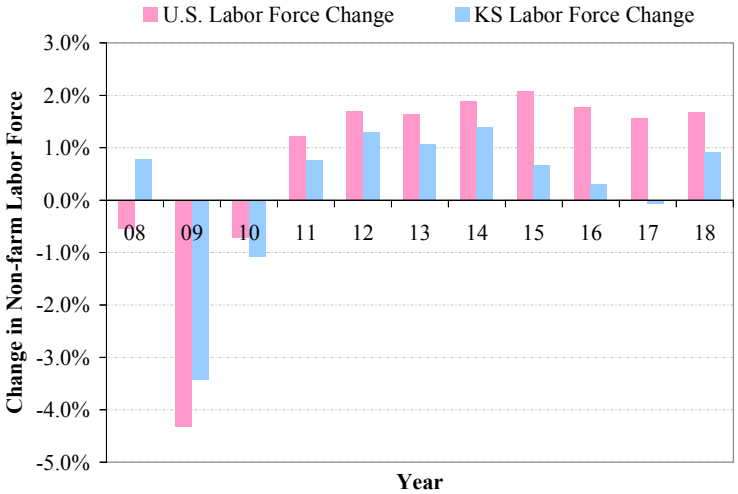

Figure 3 – Annual change in non-farm labor force in the United States and in Kansas.

(KDOL) which presented similar results for data up through 2017. Both Table 4 and Figure 3 show growth has continued every year since the Great Recession for the country as a whole. For Kansas, there appear to be at least two different phases since the Great Recession. There is moderate growth initially, but growth slows down from 2015 and becomes negative in 2017 before beginning to recover in 2018. This would help to explain the change in the number of Engineering graduates staying and working in Kansas discussed previously.

We consider one final analysis in this section – total wages earned by Engineering graduates employed in Kansas. This can be determined by multiplying the number of graduates in Kansas by the starting wages for these graduates, both given in Table 2. The result for each university by year, the sum of the three universities, and the annual average is given in millions of dollars in Table 5. Although it would be more meaningful to determine the addition resulting from the Engineering education initiative, an exact dollar amount for this could not be determined because the baseline number of graduates employed in Kansas from 2008 was not known.

Table 5 – Total Wages Earned by Engineering Graduates in Kansas [in millions]

School	2012	2013	2014	2015	2016	2017	2018	7-yr Ave
K-State	$10.58	$9.28	$11.60	$12.22	$10.26	$11.47	$15.30	$11.53
KU	$6.10	$5.67	$5.81	$7.45	$8.39	$6.90	$8.64	$7.00
WSU	$6.59	$5.97	$6.47	$7.55	$7.99	$7.43	$9.08	$7.30
Total (sum of above)	$23.27	$20.89	$23.88	$27.22	$26.64	$25.81	$33.02	$25.82

One "ball-park" approach to determine the addition is to assume that the 7-year average for Engineering graduates being employed in Kansas, 43.6%, given in Table 3 is the typical "yield" for the baseline in 2008. In this case, 43.6% yield multiplied by 875 graduates for the baseline equals 382 Engineering graduates employed in Kansas for the baseline. Furthermore, suppose that the 7-year average of the wages earned in Kansas given in Table 2b, $48,749, is assumed to be the average salary for the baseline in 2008. Finally, 382 Engineers in Kansas earning $48,749 results in $18.62 million in total wages earned. If this amount is deducted from the total given in the bottom row (shaded green) of Table 5, an estimate for the additional Engineering graduates can be determined – this is given in the first row of Table 6.

Table 6 – Estimated Additional Wages Earned by Engineers (and Staff) in Kansas [in millions]

	2012	2013	2014	2015	2016	2017	2018	Compounded Total
Engr (only)	$4.65	$2.27	$5.26	$8.60	$8.02	$7.18	$14.40	$159.67
Engr+Staff	$9.72	$4.74	$10.99	$17.98	$16.76	$15.02	$30.09	$333.75

An economic analysis[9] conducted when the Engineering education initiative was proposed found that for each engineer hired in Kansas, there are an additional 1.78 individuals hired as support staff. These support staff are paid a total of $1.0903 in wages for every $1 paid to the engineers – thus resulting in a 2.0903 multiplier factor in terms of wages paid. The last row of Table 6 gives the total wages earned by additional Engineering graduates and their support staff. The last column labeled "Compounded Total" is the total amount assuming that the Engineers (and support staff) from 2012 continued to earn the same total wages in 2013, 14, 15, 16, 17, and 18 together with the Engineers (and support staff) from 2013 earning the same total wages in 2014, 15, 16, 17, and 18, etc. It should be noted once again that these are wages earned by additional Engineers (and support staff) working in Kansas as a result of the Engineering education initiative.

If the above assumptions hold true, the state investment of $10.5 million per year or $73.5 million total for the seven years has already resulted in $333.75 million in wages earned by

additional Engineering graduates from the Kansas universities (and support staff) so far. At first glance, using the total wages earned as a comparator may seem to overestimate the effect when federal taxes and student loan debt servicing paid from the engineers' wages do not add directly to the Kansas economy. However, a multiplier effect would apply to the disposable income from these wages. When such a multiplier effect is considered, perhaps the effect on the state economy might be close to these total wages. Furthermore, many of these engineers are likely to continue working in Kansas for many years to come. The conclusion of this section, therefore, is that the Kansas Engineering education initiative should have resulted in a multi-fold return on investment.

Individual Majors and Estimate of Labor Demand

In this section, we attempt to estimate the future labor demand in Kansas for some select majors within Engineering. The first step is to determine the number of Engineering graduates from the three Kansas universities according to major and year – this is presented in Figure 4 below (and also continued on the next page). Note that publicly available data from K-State[10] and KU[11] for individual majors is only available for five years (2014-18), which is a shorter time period than the overall data previously discussed (2012-18).

There are a couple of salient features that are evident in the results. First, some majors are offered at some schools, but not at others. Out of 14 different Engineering majors at the three Kansas universities, K-State and KU each offer ten while WSU offers eight. It should be noted that K-State's

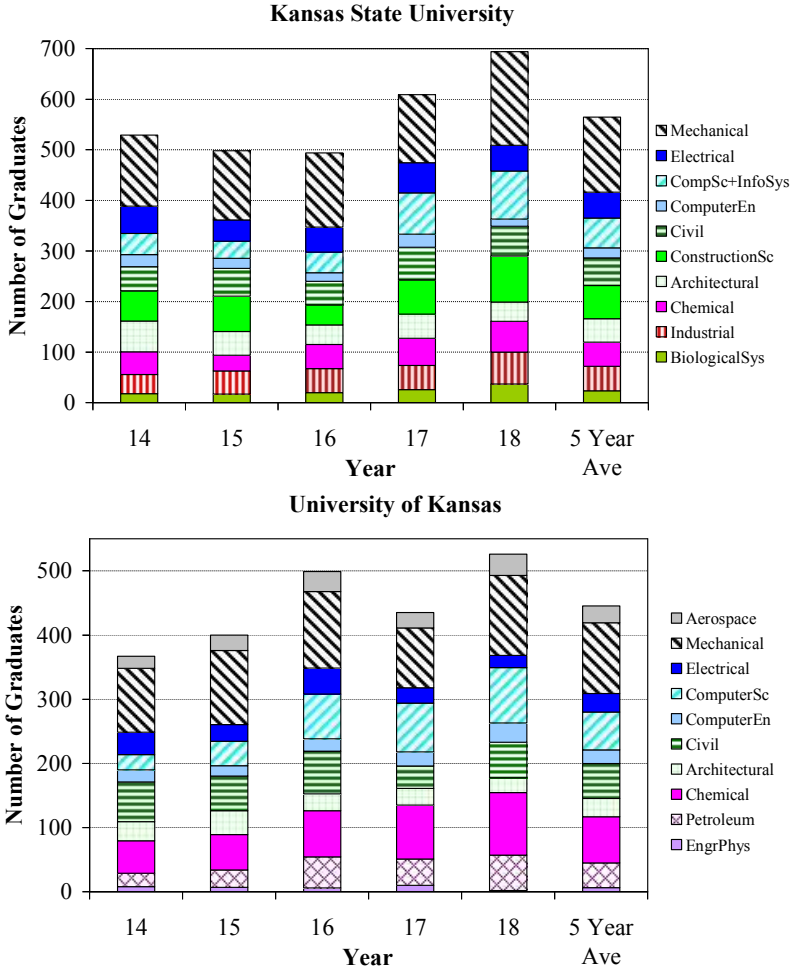

Figure 4 – Number of Engineering graduates by major: K-State (top), KU (bottom), and WSU* (next page) [*data reported to ABET]. Note that the vertical scale is different in each graph.

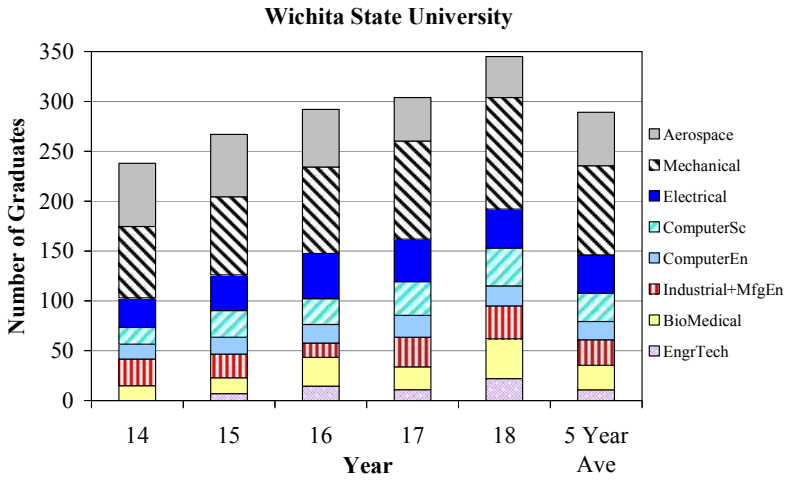

Figure 4 (continued)

Construction Science & Management program is accredited by the American Council for Construction Education rather than the Accreditation Board for Engineering and Technology (ABET) which is the typical accrediting agency for Engineering. A second observation is that there is a lot of variability from year to year in the number of graduates for any given major.

Table 7 provides the total number of graduates (sum total from schools which offer that major) for seven select Engineering majors. These seven majors were chosen for closer study because they were identified as high-demand fields by KDOL.[12] The standard deviation (σ) in the number of graduates for six out of these seven majors is 10% or more. Since there is a lot of variability, we will use the 5-year average as the representative number in the ensuing analysis rather than choosing one single particular year.

Table 7 – Total Number of Graduates in Select Engineering Majors

Major (Schools)	2014	2015	2016	2017	2018	5-yr Ave	σ	Max	Min
Aerospace (KU & WSU)	82	87	89	68	74	80	8 (10%)	89	68
Civil (K-State & KU)	110	109	113	100	114	109	5 (5%)	114	100
Computer Engr (all three)	58	53	55	70	64	60	6 (10%)	70	53
Computer Sc (all three)	83	99	136	191	219	146	52 (36%)	219	83
Electrical (all three)	118	104	135	126	109	119	11 (10%)	135	104
Industrial (K-St & WSU)	65	70	62	78	96	74	12 (16%)	96	62
Mechanical (all three)	311	340	353	326	422	348	39 (11%)	421	311

KBOR provides information about the percentage of Engineering graduates, by major, that are employed in the region which is defined as Kansas or Missouri. This information takes into account the large number of graduates who work in the Kansas City metropolitan area with much of the employment for this metro area being on the Missouri side. The KBOR data[13] for the seven selected majors who are employed within the region is given in Table 8.

With the exception of Aerospace and Industrial Engineering, two-thirds to three-quarters of the graduates are employed in the Kansas-Missouri region. This is probably a reasonable "ball-park" figure since most graduates would naturally find employment in the region. In terms of the remaining quarter to third, some pursue full-time study in graduate school, some are international students returning home, and some unfortunately do not find employment in their career field.

The two-thirds to three quarters regional employment figure is in marked contrast to the overall data (cf. Table 3) where less than half are employed in Kansas. Determining the numbers employed in Kansas provides a more direct measure of the impact of the Engineering education initiative. Thus, the

Table 8 – Proportion of Engineering Graduates Employed in the Region (Kansas or Missouri)

School	Aerospace	Civil	Comp En	Comp Sc	Electrical	Industrial	Mechanical
K-State	N/A	73%	74%	68%	75%	49%	66%
KU	42%	69%	82%	72%	66%	N/A	61%
WSU	71%	N/A	71%	71%	70%	65%	75%
Weighted Average	61.5%	71.0%	75.9%	70.2%	71.2%	54.5%	66.7%

overall average found earlier, 43.6%, is the more appropriate value to use as the "yield" of Engineering graduates employed in Kansas. Although the question about whether this is an appropriate value to use for individual majors remains, this is the best "yield" estimate for employment in Kansas that is possible based on the available information. If the average number of graduates in individual majors given in Table 7 (i.e., values in the green column) is multiplied by the 43.6% estimated "yield" of Engineering graduates employed in Kansas, then the values given in Table 9 results.

Table 9 – Estimated Annual Number of Engineering Graduates Employed in Kansas, by Major

School	Aerospace	Civil	Comp En	Comp Sc	Electrical	Industrial	Mechanical
KS employed	35	48	26	64	52	32	152

The next step is to determine the labor demand for these majors in Kansas. BLS[14] provides current employment numbers and labor demand in specific occupations for the entire United States as well as employment numbers for each individual state. Two different caveats need to be noted. First, some occupations correlate directly to a single major while others do not. For example, both Computer Engineering and Computer Science graduates can be employed in occupations like (current Kansas employment numbers in parentheses): **software developers** (7440), **network administrators** (5820), **systems analysts** (4810), network architects (1600), and programmers (1530) to name a few. Here, the bolded occupations were identified by KDOL[12] as high-demand areas. Computer Science graduates tend to have more software and programming experience while Computer Engineering graduates focus more on systems and networking. Another caveat relates to the minimum entry-level education associated with some of these occupations. Although the BLS summary states that network administrators usually have a Bachelor's degree, the detailed entry notes that some positions may only require a postsecondary certificate or an associate's degree. Another example is systems analysts which states that some firms hire analysts with business or liberal arts degrees. It is very clear from the BLS data that there is significant demand for computer-related occupations. However, it is difficult to gauge how much of that will be filled by bachelor's Engineering graduates, business or liberal arts bachelor's information technology graduates, associate's degree graduates or even postsecondary certificate holders. For this reason, we will not attempt to gauge demand for computer-related occupations, but will focus on analyzing Kansas labor demand for Aerospace, Civil, Electrical, Industrial, and Mechanical Engineers.

Table 10 presents the BLS[14] data, by specific Engineering occupation, for current employment numbers in the U.S. and Kansas as well as the estimated job growth rate over 10 years for the entire U.S. The BLS does not provide job growth for states so we estimated it by assuming that the growth rate for Kansas is the same as the U.S. First, the Kansas to U.S. employment ratio is determined for each occupation by taking the number from the second row of Table 10 and dividing it by the first row – the result is given in the first row of Table 11. Next, the annual growth in the U.S. (first row of Table 10 multiplied by $1/10^{th}$ of the third row) is multiplied by the ratio (first row of Table 11) to determine the annual growth in Kansas jobs – this is given in the second row of Table 11. Next, assuming that a typical engineer's career encompasses 20 years, the replacement rate will be $1/20^{th}$ of the number for the Kansas employment number – this replacement number is given in the third row of Table 11. Finally, the sum of the second and third rows result in the annual growth and replacement number for

Kansas – this is given in the fourth row of Table 11. The last row in Table 11 presents the KDOL estimate mentioned by KBOR.[12] Except for Industrial Engineering, our estimates of annual growth and replacement are more conservative than those determined by KDOL. Perhaps some occupations (Civil, Electrical, and Mechanical Engineering) have higher turnover than our estimate of 1/20th.

Table 10 –Employment and Estimated Labor Demand by Major

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
U.S. employment	69,600	303,500	324,600	257,900	288,800
KS employment	2200	2340	1960	2920	2710
Estimated U.S. growth (2016-26)	6%	11%	7%	10%	9%

Table 11 – Estimated Labor Demand in Kansas by Major

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
KS/U.S. employment ratio	3.2%	0.8%	0.6%	1.1%	0.9%
Annual KS growth	13	25	13	28	24
Annual replacement (KS employ/20)	110	117	98	146	136
KS annual growth + replacement	123	142	111	174	160
KBOR/KDOL estimate for KS	135	198	188	172	207

The first row in Table 12 provides information about the *total* number of graduates in 2018 according to KBOR.[12] The second row lists the total number of Bachelor's graduates in 2018 from Table 7. Although there is a significant difference between the two numbers, it is because the KBOR numbers are total degrees awarded including graduate degrees. The third row provides the 5-year weighted average number of Bachelor's graduates from Table 7. Finally, the last row comes from Table 9 – the estimated number of Bachelor's graduates employed in Kansas each year.

Table 12 – Engineering Graduates and Typical Numbers Employed in Kansas by Major

Category	Aerospace	Civil*	Electrical	Industrial	Mechanical
2018 total graduates KBOR	103	176*	159	184*	483
2018 total graduates from Table 7	74	114	109	96	422
5-year average number from Table 7	80	109	119	74	348
Ave KS employ number from Table 9	35	48	52	32	152

A number of observations can be made about these results. First, the KBOR listing (top row of Table 12) for total number of graduates includes Master's and Ph.D.'s. At WSU, many of the graduate students are part time students who work full-time as Engineers. This may also be true, to a limit, for KU which is located about an hour from the Kansas City metro area. Since these part-time students already work as Engineers, counting them as new additions upon graduation to fill growth or replacement positions would not be appropriate. Furthermore, not all graduates will decide to work in the state of Kansas. Thus, the actual number is likely to be somewhere between the absolute maximum number listed by KBOR and the typical "yield" for Kansas Bachelor's graduates.

When the demand given in the last two rows of Table 11 are compared to the likely numbers in the middle rows of Table 12, clearly a gap exists for some of these majors. For Mechanical Engineering, the available numbers appear to meet Kansas demand – this is also KBOR's conclusion. With regard to Industrial Engineering, the BLS detailed entry notes that "many Industrial Engineers have degrees in Mechanical Engineering, Electrical Engineering, Manufacturing Engineering, Industrial Engineering Technology, or General Engineering." Thus, much fewer Industrial Engineers are needed to fill the need in this occupational category. KBOR also concludes that the existing graduation numbers are sufficient to meet Kansas demand. Civil

Engineers are involved with all types of infrastructure construction while Architectural Engineers are limited to building constructions. In some respects, Architectural Engineering may be viewed as a specialized subset of Civil Engineering. The average number of Architectural Engineers graduating from K-State and KU total 75 graduates per year. These graduates are likely to meet some of the demand for Civil Engineers in Kansas for the appropriate types of projects. Although KBOR concludes that the supply of Civil Engineers does not meet demand, perhaps the gap is not that large. In terms of Electrical Engineering, there is a gap that is moderate or large depending on which demand estimate is assumed. Finally, there appears to be a sizeable gap where demand exceeds the supply of Aerospace Engineering graduates who will then work in Kansas.

Summary

The retention of graduates from Engineering education expansion in the state of Kansas was considered. The investment by the state has resulted in a significant increase in the number of Engineering graduates by K-State, KU, and WSU. KU reached its expansion goal early in 2016, K-State has graduated a significant number of Engineering graduates in raw number terms, and WSU provided the highest percentage of its Engineering graduates staying and working in Kansas when compared with K-State and KU. In addition to retention-related analysis, some state of Kansas labor demand estimates were made for individual Engineering majors that are in high demand. Besides computer-related occupations, Aerospace, Civil, and Electrical Engineering appear to be high-demand fields for the state of Kansas.

Bibliography

1 N. Augustine, 8 Jun 2012, "America's Education Problem Isn't Money, It's How We Spend It," *U.S. News and World Report*.

2 J. Sununu & M. Cardona, 12 Jun 2013 "STEM fund key to U.S. global competitiveness,"*The Hill Congressional Blog*, retrieved 7 Jun 2019 from https://thehill.com/blogs/congress-blog/education/305061-stem-fund-key-to-us-global-competitiveness.

3 T. Carpenter, 25 May 2011, "Governor signs KPERS, engineering bills," *Topeka Capital-Journal*.

4 *Kansas Board of Regents*, "Handout: University Engineering Initiative Act," retrieved 7 Jun 2019 from https://www.kansasregents.org/resources/PDF/HANDOUT_KansasBoardofRegents_Engineering_April2019.pdf.

5 E. Bowen, Christiadi, J. Deskins, & P. Manzi, Oct 2014, "How Much Do West Virginia College Graduates Add To the State's Economy," *West Virginia University Bureau of Business and Economic Research*, retrieved 7 Jun 2019 from http://busecon.wvu.edu/bber/pdfs/BBER-2014-07.pdf.

6 Mid-America Regional Council, May 2018, "A Labor Analysis of the KC Global Design Industry," retrieved 7 Jun 2019 from http://www.kcworkforce.com/Assets/reports/GlobalDesignTIE_LaborAnalysis.pdf.

7 Federal Reserve Bank of St. Louis, a) "Civilian Unemployment Rate" b) "Unemployment Rate in Kansas," c) "All EmployeesTotal Nonfarm Payroll," and d) "All Employees: Total Nonfarm in Kansas," retrieved 11 Jun 2019 from https://fred.stlouisfed.org/series/UNRATE/, https://fred.stlouisfed.org/series/KSURN, https://fred.stlouisfed.org/series/PAYEMS and https://fred.stlouisfed.org/series/KSNA.

8 Kansas Department of Labor, "2018 Kansas Economic Report," retrieved 11 Jun 2019 from https://klic.dol.ks.gov/admin/gsipub/htmlarea/uploads/Economic%20Report%202018.pdf.

9 Wichita State University Center for Economic Development and Business Research, Dec 2009, "Economic and Fiscal Impact of Engineering Professionals in Kansas and Analysis of Proposed Increase in University Funding for Engineers," retrieved 26 Jun 2019 from http://webfiles.wichita.edu/cedbr/EngFINAL.pdf.

10 Kansas State University College of Engineering, "2018-19 Factbook," p. 32, retrieved 11 Jun 2019 from https://www.engg.ksu.edu/docs/college-data/fact-book.pdf.

11 University of Kansas School of Engineering, "Enrollment and Graduation Data," retrieved 11 Jun 2019 from https://engr.ku.edu/enrollment-and-graduation-data.

12 Kansas Board of Regents, "Goal 2: Metric 2," *Foresight 2020*, p.18, retrieved 11 Jun 2019 from https://www.kansasregents.org/resources/KansasBoardofRegents_2019ProgressReport_FINAL.pdf.

13 Kansas Board of Regents, "KSDegreeStats.org," data for individual degree titles retrieved 11 Jun 2019 from

https://ksdegreestats.org/program_search.jsp.
14 Bureau of Labor Statistics, "Occupational Outlook Handbook," data for individual occupations retrieved 11 Jun 2019 from search.jsp https://www.bls.gov/ooh/architecture-and-engineering/home.htm.

Biographical Information

ROY MYOSE is Professor of Aerospace Engineering at Wichita State University.

L. SCOTT MILLER is Professor and Chair of Aerospace Engineering at Wichita State University.

STEVEN SKINNER is Associate Dean of Engineering and Professor of Electrical Engineering at Wichita State University.

JAMES MYOSE is a junior double majoring in Economics and Mathematics at Kansas State University.