The Retention of Graduates from Engineering Education Expansion in Kansas

Roy Myose, L.Scott Miller, Steven Skinner,
College of Engineering, Wichita State University

& James Myose
College of Arts & Sciences, Kansas State Univ.

Background on Need for Engineering Expansion

- There is significant growth & demand for STEM graduates in the U.S.
  - Studies have shown that 50-85% of GDP growth in U.S. is due to advances in science & engineering*
- State of Kansas funded an Engineering initiative in 2011
  - KU, K-State, & WSU were each funded by $3.5 million per year to increase the number of Engineering graduates
  - Goal is to increase from 875 grads to 1367 in ten years; that is, an increase of 164 grads by each school

*Reference: Norm Augustine, *U.S. News & World Report*, 8 June 2012

Background on Current State of Engineering Expansion

School	Baseline	2012	2013	2014	2015	2016	2017	2018	Goal
K-State	423 (0)	480 +57	471 +48	529 +106	498 +75	494 +71	609 +186	694 +271	587 +164
KU	255 (0)	335 +80	338 +83	367 +112	400 +145	499 +244	435 +180	526 +271	419 +164
WSU	197 (0)	214 +17	208 +11	238 +41	267 +70	292 +95	304 +107	345 +148	361 +164

- This table shows progress made so far by the three universities in Kansas with Engineering expansion*
  - Engineering **graduation numbers** are in black and increase in red
  - Baseline from 2008 and goal in 2021 after 10 years of expansion

*Reference: Kansas Board of Regents (KBOR), 2019, *Handout Univ Engineering Initiative*

Background on Current State of Engineering Expansion

School	Baseline	2012	2013	2014	2015	2016	2017	2018	Goal
K-State	423 (0)	480 +57	471 +48	529 +106	498 +75	494 +71	609 +186	694 +271	587 +164
KU	255 (0)	335 +80	338 +83	367 +112	400 +145	499 +244	435 +180	526 +271	419 +164
WSU	197 (0)	214 +17	208 +11	238 +41	267 +70	292 +95	304 +107	345 +148	361 +164

- KU reached its goal in 2016
- K-State reached its goal in 2017
- WSU has been making steady progress over the past 7 years and has achieved a 75% increase over their baseline

Motivation / Methodology

- Motivation: are there other important metrics besides raw number of Engineering graduates?
  - What is the **economic** impact for the State?
  - Are universities in Kansas meeting the **labor demand** for discipline specific types of Engineers?

- Methodology:
  1) Determine economic impact from the number of Engineering graduates employed in Kansas and their entry-level wages
  2) Estimate future labor demand for discipline-specific areas of Engineering

Information Available about Engineering Graduates Employed in Kansas

- Table shows number of Engineering graduates employed in Kansas*

School	2012	2013	2014	2015	2016	2017	2018
K-State	219	193	225	221	203	230	288
KU	133	122	115	156	180	147	176
WSU	149	131	145	154	162	165	184

- Table shows starting wages of Engineering grads employed in KS*

School	2012	2013	2014	2015	2016	2017	2018
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

*Reference: Kansas Board of Regents (KBOR), 2019, *Handout Univ Engineering Initiative*

Information Available about Engineering Graduates Employed in Kansas

- Table shows number of Engineering graduates employed in Kansas*

School	2012	2013	2014	2015	2016	2017	2018
K-State	219	193	225	221	203	230	288
KU	133	122	115	156	180	147	176
WSU	149	131	145	154	162	165	184

- Without going into details, there are two main "take-aways"
  1) Data is available about KS employment & 2) average wages are:

School	$48,749 overall for all schools over 7 yrs (to be used later)						
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

*Reference: Kansas Board of Regents (KBOR), 2019, *Handout Univ Engineering Initiative*

Information Available about Engineering Graduates Employed in Kansas

- Table shows number of Engineering graduates employed in Kansas

School	2012	2013	2014	2015	2016	2017	2018
K-State	219	193	225	221	203	230	288
KU	133	122	115	156	180	147	176
WSU	149	131	145	154	162	165	184

- Since these graduates are employed in Kansas, they have a direct impact on the State's economy
  - Would like to know what portion of these graduates are a result of the **increase from the Engineering initiative**
  - This requires information on how many grads were employed in KS during 2008 baseline year – **unfortunately this is not known**
  - Instead, estimate with **percentage of grads** employed in Kansas

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%
Wt Ave	48.7%	43.9%	42.8%	45.6%	42.4%	40.2%	41.4%	43.6%

- Table provides the percentage of Engineering graduates employed in Kansas from each university
  - Last row has **weighted average** (total employ in KS / total grads)
  - Last column has the **7-year** average
  - Wt average over 7-years of **43.6%** will be used in later estimate

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%
Wt Ave	48.7%	43.9%	42.8%	45.6%	42.4%	40.2%	41.4%	43.6%

- On average, percentage employed in KS: K-State = **42%**, KU ~ **36%**, and WSU ~ **59%**
  - Higher proportion of WSU grads work in KS compared to others
  - Purpose of state's funding is to increase number of Engr grads staying & working in KS rather than exporting majority out of state
  - WSU provides better "bang for the buck" to the state

Returning to the First Question

What is the economic impact of the Engineering initiative for the State?

Determining Total Wages Earned by Engineering Grad Employed in Kansas

- Recall earlier data on Engr grads employed in KS & their wages

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

- Total wages earned by Engr grads employed in KS is determined by multiplying the number of grads (top line) & their wages (bottom line)

Year	2012	2013	2014	2015	2016	2017	2018
Total wages (millions)	$23.27	$20.89	$23.88	$27.22	$26.64	$25.81	$33.02

Method to Estimate Economic Impact of Engineering Initiative to Kansas

- Estimate made by using 7-year average "yield" of **43.6%** as the baseline proportion of Engineering grads employed in Kansas
  - Baseline 875 grads multiplied by 43.6% results in 382 Engr grads employed in KS
- Use 7-year average for wages earned in Kansas of $48,749
- 382 Engr earning $48,749 results in $18.62 million for the baseline
  - Deduct $18.62 million from the previous total (green shaded row)

Previous	$23.27	$20.89	$23.88	$27.22	$26.64	$25.81	$33.02
(in millions)	2012	2013	2014	2015	2016	2017	2018
Additional	$4.65	$2.27	$5.26	$8.60	$8.02	$7.18	$14.40

- Result is estimated amount of additional wages due to Engr Initiative

Estimate of Economic Impact of Engineering Initiative to Kansas

- Compounding effect assuming that the 2012 grads earn the same salary in 2013, 14, etc. up through 2018
  - Similarly for other years, then add up to get compound result

(in millions)	2012	2013	2014	2015	2016	2017	2018	Compound
Engr only	$4.65	$2.27	$5.26	$8.60	$8.02	$7.18	$14.40	$159.67

- Above is for direct wages earned by additional Engr grads in KS
- Economic analysis* made when Engr initiative was proposed found that for each $1 in Engr wages, support staff is paid $1.0903 in wages
  - Result of additional Engr & additional support staff is the following:

(in millions)	2012	2013	2014	2015	2016	2017	2018	Compound
Engr+Staff	$9.72	$4.74	$10.99	$17.98	$16.76	$15.02	$30.09	$333.75

*Reference: WSU Center for Economic Development & Business Research, Dec. 2009

Second Question

What is the future labor demand for discipline-specific areas of Engineering?

Labor Demand Estimate: Step 1a – Discipline Specific Graduates

- Table gives total number of grads in seven high-demand majors

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

- 5-yr average and standard deviation (S.D.) are also given
- Most majors have a lot of variability as indicated by the large S.D.

Step 1b – Estimating Discipline Specific Employment in Kansas

School	Aerospace	Civil	Comp En	Comp Sc	Electrical	Industrial	Mechanical
5-yr Ave	80	109	60	146	119	74	348
KS	35	48	26	64	52	32	152

- Table shows **5-year average** of graduates in specific disciplines
- Also shown is the resulting "yield" (i.e., **43.6%**) of these graduates who would typically work in Kansas
- Before considering labor demand, two caveats need to be noted:
  1) Some occupations do not correlate directly to a single major; e.g., computer engineers & computer scientists can work as software developers, network administrators, and systems analysts
  2) The minimum entry-level education is less than a Bachelor's degree for many of these occupations

Step 1b – Estimating Discipline Specific Employment in Kansas

School	Aerospace	Civil	Comp En	Comp Sc	Electrical	Industrial	Mechanical
5-yr Ave	80	109			119	74	348
KS	35	48			52	32	152

- Difficult to gauge how many computer-related occupations need to be filled by Bachelor's Computer Engr & Sc grads
- Thus, Kansas labor demand analysis in this presentation will focus on Aerospace, Civil, Electrical, Industrial, and Mechanical Engineers

Step 2 – Employment & 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
10-yr U.S. growth	6%	11%	7%	10%	9%

- Table above provides data* about current employment numbers, by occupation for the U.S. & KS as well as estimated growth for 2016-26
- If the second row is divided by the first row, the KS to U.S. employment ratio can be determined for each occupation

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
KS/U.S. employ	3.2%	0.8%	0.6%	1.1%	0.9%

*Reference: Bureau of Labor Statistics *Occupational Outlook Handbook*

Step 2 – Employment & 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
10-yr U.S. growth	6%	11%	7%	10%	9%

- To determine annual KS growth, U.S. employment number (top table 1st row) is multiplied by 1/10th of the annual growth rate (top table last row) and by the KS-to-US employment ratio (bottom table top row)
- **Result** is given in the second row of the table below

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
KS/U.S. employ	3.2%	0.8%	0.6%	1.1%	0.9%
Annual KS growth	13	25	13	28	24

Step 2 – Employment & 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
10-yr U.S. growth	6%	11%	7%	10%	9%

- To determine annual KS replacement numbers, take 1/20th of the KS employment numbers (top table 2nd row)
- **Result** is given in the last row of the table below

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
KS/U.S. employ	3.2%	0.8%	0.6%	1.1%	0.9%
Annual KS growth	13	25	13	28	24
Annual KS replace	110	117	98	146	136

Estimated Labor Demand by Major

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
Annual KS growth	13	25	13	28	24
Annual KS replace	110	117	98	146	136
Sum of above	123	142	111	174	160
KDOL estimate*	135	198	188	172	207

- Adding the annual KS growth and the annual KS replacement numbers (i.e., sum of 1st & 2nd rows)
- Results in the estimated KS labor demand (3rd row)
- Kansas Department of Labor (KDOL) estimates (shown in last row) are generally slightly larger demand for these majors
  - Our estimates are generally conservative

*Reference: Kansas Board of Regents (based on KDOL data), *Foresight 2020*

Labor Demand vs. Graduates by Major

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
Current study	123	142	111	174	160
KDOL estimate	135	198	188	172	207

- Table above is previously found labor demand (current study & KDOL)
- KBOR reported 2018 total number of graduates by major, including M.S. & Ph.D. (top row) while bachelor's grads (2nd row) is less than that

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
2018 total grads*	103	176	159	184	483
2018 B.S. grads	74	114	109	96	422

*Reference: Kansas Board of Regents (based on KDOL data), *Foresight 2020*

Labor Demand vs. Graduates by Major

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
Current study	123	142	111	174	160
KDOL estimate	135	198	188	172	207

- Previously shown 5-yr average of B.S. grads & those employed in KS are given in the last two rows
- Regardless of the (row) category, labor demand for Aerospace, Civil, & Electrical Engineers is not met by number of graduates staying in KS

Category	Aerospace	Civil	Electrical	Industrial	Mechanical
2018 total grads*	103	176	159	184	483
2018 B.S. grads	74	114	109	96	422
5-yr ave B.S. grads	80	109	119	74	348
Ave KS employ	35	48	52	32	152

Conclusions

- State of Kansas began an Engineering initiative in 2011
  - KU reached its goal early in 2016
  - K-State has graduated a large number of Engr grads
  - WSU provides highest percentage of its Engr grads working in KS
- $159.67 million (compound total) of wages from additional Engr in KS due to Engr Intiative vs. $73.5 million invested by State in 7 yrs
- When staff hired to support these additional Engr's are included, compound total is $333.75 million
- Graduation numbers for specific disciplines in Engineering were determined
- Future labor demand for Aerospace, Civil, & Electrical Engineers as well as Computer-related fields exceed graduation numbers in Kansas