

UNIVERSITY OF NEBRASKA-LINCOLN
COLLEGE OF ENGINEERING

STRATEGIC PLAN

2013-2018 and beyond

Executive Summary

The College of Engineering at the University of Nebraska has undertaken a dramatic and aggressive transformation to better serve the State's engineering workforce and technology-based economic development needs. It is our mission to explicitly link our education and research programs at the highest possible levels to the citizens we serve. This must be done in a broader context of a global society with an insatiable need for engineers and technology innovation. In realizing this goal, we will become nationally and internationally recognized for how well and how broadly our programs support our constituents.

One of the core ingredients to the success of this transformation is establishing strong, lasting and meaningful ties to the industries of Nebraska; collaborations which enhance the ability to both attract and develop talent as well as produce innovation under broader vision and mission-focused initiatives. While this principle applies across the State, first and foremost, this must include coupling with the strong industrial base in Omaha. It is imperative that the College create pursue the high-impact partnerships envisioned in the foundation of the Peter Kiewit Institute. As such, the infrastructure at PKI will play a central role in the expanded mission and vision of the College.

The transformation of the College has both engineering education, and engineering research and development as equal elements of a singular service focused mission. Highlights of engineering education initiatives include creating first-year student experiences focusing on hands-on exposure to tools and methodologies and introductions to engineering in the context of key industry sectors, a revamping of the capstone design experience, and the creation of a curriculum on essential non-technical skills needed for life-long careers of leadership, innovation and impact. Research and development based initiatives center around manufacturing, medicine and the life sciences, and security. The goal is to create a number of national centers that will define the College and the University as national/international thought leaders in a number of areas of State, national and global importance. This, in turn, will increase the attractiveness of the region for economic development.

Examples of major, growth-focused initiatives that are specifically targeted to fully couple Omaha and PKI into a single, integrated engineering college include:

- creation and Omaha roll-out of a 'leadership, innovation and impact' curriculum built with and around major industries in Omaha and the State,
- restructuring of engineering capstone curricula to become explicitly multidisciplinary and industry focused,
- PKI-centered partnership with IS&T and industry/government around the intersection between big data/high performance computing and civil infrastructure safety/security,
- PKI-centered partnership with IS&T and industry around the intersection between big data/high performance computing and construction safety/efficiency,
- collaboration with Omaha based food industries to create a national center/institute on the theme of 'food factory of the future',
- continued expansion of research collaborations with UNMC,
- development of collaborations with STRATCOM through the NSRI.

Implicit in this expansion of activity and focus is a concomitant growth in enrollments, research productivity, infrastructure and faculty. It will not be easy. We are in a world-wide competition for talent. But it will, for the first time in perhaps decades, energize the College and all of its partners around the truly state-of-the-art scholarship and intellectual vitality that the citizens and industries of Nebraska need and deserve.

Part I: Planning for Unprecedented Growth

I.1: The Challenge

Since its inception in 1877, the College of Engineering has been charged with supporting the technology-based economic development of Nebraska through workforce training and engineering expertise. The College has grown significantly and has 7 departments with 12 ABET accredited engineering degree programs and an accredited Construction Management degree program. It is home to ~165 tenured/tenure-track faculty, 2700 undergraduates, and ~400 full time graduate students. Research expenditures have increased to ~\$38M and in the last five years the College broke into the top 100 engineering colleges in the US News & World Report rankings. In 2011, the College was welcomed into the Big Ten Plus Engineering Consortium which, in addition to the Big Ten colleges of engineering, includes MIT, Cornell, Carnegie Mellon, Georgia Tech, Berkeley, Stanford and UT-Austin. We have indeed come a long way.

But there is still a very long way to go. The College has not fully advantaged the industry base of the State, particularly in Omaha. We have not established nationally and internationally renowned pillars of expertise around Nebraska's major manufacturing industries: food, civil infrastructure, and equipment/components/devices. As a result, we have not uniformly developed and sustained high-impact R&D programs that significantly and positively impact our State's economy. From an engineering education perspective, until just two years ago, we graduated less than 425 B.S. level engineers per year corresponding to a six-year graduation rate of no better than 45% for students who started in engineering and graduated with an engineering degree. Symptomatic of this low productivity is the fact that less than 70% of the incoming engineering freshman stay in engineering into the sophomore year (though close to 85% do remain in the University system).

The time has come for the College to raise the quality and volume of its engineering education and service focused R&D enterprises to the level that Nebraskans expect and deserve. But it must be noted at the outset, that all this must be done in the context of a global society that is starved for engineering talent. The 379 ABET accredited colleges of engineering in the US produce around 75,000 new B.S. level engineers per year. To put that in perspective, the combined engineering hiring needs of just Kiewit and Halliburton alone accounts for ~5,000 or ~7% of those graduates. So even when we reach our ten year goal of increasing our rate of minting new engineers by 50% from ~400 to 600 per year, this will not fully meet demand. We are in a global competition for a very precious commodity.

I.2: Our Mission

The mission of the College is fivefold. We must train excellent engineers to supply the STEM workforce needs of Nebraska. We must, at the same time, teach the essential non-technical skills necessary for our graduates to become leaders and innovators into the future. We must engage with industry across the State in applied research to support economic development today. At the same time, we must be leaders in translational research that will ensure that today's emerging science and technologies will drive Nebraska's economic engine tomorrow. And finally, we must be internationally renowned for our basic research from which technologies and businesses of the future for the State will be created. For the good of the entire State of Nebraska, we must make this mission a reality.

We must do three things. 1) We must create unique, highly visible, high impact programs that will attract students from Nebraska and from around the world to study engineering at the College. 2) We must work closely with Nebraska industries, with the heaviest concentration being in Omaha, to give them preferred access to our students. And 3) we must establish global research and development leadership in a number of critically important technology sectors to attract industries, entrepreneurs and researchers to the Omaha – Lincoln metropolitan corridor.

Over the past two years, we have aggressively begun to push forward on all three fronts. We are working with industry in Omaha and across the State to develop a unique, integrated curriculum that will expose *all* of our engineering students to the leadership, innovation, and impact skills they will need to succeed and contribute in the workplace from day one. As part of that curriculum, we are providing students with an understanding and context for pursuing career development opportunities such as internships and study abroad. At the same time, we have intentionally begun working with Nebraska industries to create meaningful internships for our students. And on the technology development front, we have begun building major university-industry partnerships around the broad themes of manufacturing, healthcare, and national defense. Our manufacturing focus is on the three major industries of Nebraska, manufacturing of food, civil infrastructure, and equipment/components/devices. Our goal is to create a number of national centers focused on key aspects of these manufacturing themes.

It will take teamwork to make this vision a reality. We have started discussions with our colleagues in the College of Information, Science & Technology at UNO to develop an initiative at the intersection of big data and engineering around construction and infrastructure. Through strategic initiatives like this, we will grow more and better partnerships with Nebraska's industry base from Omaha to Scottsbluff, and from Deshler to Norfolk.

But there is an equally important role that industry must play in this as well. They need to create the career opportunities and work environments that make them 'employers of choice'. And we must all work together to give each of our Nebraska communities a clear and compelling 'pride of place' that will make Nebraska *the* place to work and live. The challenge of manufacturing Nebraska is great.

I.3: Our Approach to Growth

In order to realize this vision, it will be essential to grow both the human capital and physical infrastructure of the college. Over the next five years, with natural replacement hiring plus new positions, we plan to hire a total of 100 tenure/tenure-track faculty, bringing our faculty size to 215. This will include a net increase of about 50 new positions. There must, at the same time, be an expansion and enhancement of our existing facilities in both Omaha and Lincoln. This transformation must also include unprecedented growth in student enrollments in areas of workforce need, and sharp increases in externally funded research that supports basic engineering science and industry innovation. In order to connect with Nebraska's most significant engineering needs, we will focus our initial efforts on the broad themes of manufacturing, medicine and defense.

At the same time, in order to build a college with state-wide relevance, our growth initiative has to involve significant structural changes to the College. Particular focus has to be on enrollment and research growth in Omaha where opportunities must be identified and pursued to increase

enrollments at PKI, where manufacturing is a key priority of the Omaha Chamber of Commerce, and where collaboration with UNMC and STRATCOM are targeted priorities for the College. Another imperative will be for College leadership to be as identifiably present in Omaha as it has historically been in Lincoln[§]. This is a critical element in removing and blurring the real and perceived boundaries within and across the College that have been an impediment for decades.

I.4: Five Year Targets

The overarching mandate in developing our growth plan is to build the best college possible that is consistent with the values, goals, resources, and needs of Nebraska. A world-class college that is both education and research intensive, built around the State, is a self-consistent and achievable goal.

In articulating a vision and roadmap for the College, it is useful to benchmark against our peer aspirant universities. Table I on the following page provides a set of targets for our growth, based on a blend of UNL enrollment goals and research productivity metrics characteristic of the top engineering colleges. It should be noted that enrollment goals are 5-year targets while research expenditure projections reflect 10-years goals. This is due to the time lag inherent with hiring tenure-track faculty and their ability to build highly successful, externally funded research programs. There is also an implicit assumption that the federal research funding will return back to pre-recession levels in the relatively near future. The key goals are:

- 33% increase in undergraduate enrollment from 2700 to 3600 over 5-years,
- 50% increase in B.S. production from ~400 to 600 per year over 10-years,
- creation of an Omaha-based Masters degree program for working professionals,
- 2 – 3 fold expansion of the externally funded research activity over 10-years,
- concomitant growth of the graduate research training enterprise,

As previously stated, there will be a disproportionate focus of new resources and programs in Omaha consistent with the large percentage of industries there. A comparison of key differentials is shown in Table II. Referring back to Table I, it can be seen that an increase in undergraduate enrollment of +400 in Omaha represents a 50% increase relative to current enrollments, while an additional 500 students in Lincoln represents a 26% increase. Adding 30 faculty in Omaha in the next 5-years is a 70% increase and brings balance to faculty-student ratios between Omaha and Lincoln.

Every aspect of our growth initiative is challenging. The College will have to examine its structure, priorities and practices in order to become more efficient and more focused on high return opportunities. We will have to partner effectively with the recruitment and admissions enterprises at UNO and UNL and will have to expand our own recruitment staff. We will have to benefit from campus programs focused on student success, retention, and career services and will have to build programs of our own to specifically meet the needs of engineering students. We will

[§] The College currently maintains an Associate Dean for Omaha programs to provide continuity of administrative leadership in Omaha. In order to further build essential relationships in Omaha, every member of the college leadership team (Dean, Associate Dean for Undergraduate Programs, Assistant Deans for Academics & Administration and Business & Finance) will spend at least one day a week working at the PKI facility in Omaha. The new Associate Dean for Faculty and Graduate Programs is a full time PKI faculty member. Lincoln-based department chairs and center directors from the college and UNL campus leaders will also spend focused time at PKI and in Omaha.

Table I: Target enrollment and research metrics for the College.

The emphasis on growth in Omaha, consistent with integration with the large industrial base there, is clearly evident.

| | 2012 actual | 2018+ projections |
|--|-------------|------------------------|
| Enrollment – Undergraduate | | |
| Undergraduate – Lincoln | 1,900 | 2,400 |
| Undergraduate – Omaha | 800 | 1,200 |
| Undergraduate Total | 2,700 | 3,600 |
| Professional Masters | | |
| Professional Masters – Lincoln | - | 100 |
| Professional Masters – Omaha | - | 200 |
| Professional Masters Total | - | 300 |
| Master of Science / Ph.D.s | | |
| M.S. / Ph.D. – Lincoln | 300 | 600 – 650 |
| M.S. / Ph.D. – Omaha | 100 | 350 – 400 |
| M.S. / Ph.D. Total | 400 | 1,000 |
| Research Expenditures | | |
| Research Expenditures – Lincoln | \$33M | \$56 – \$70M |
| Research Expenditures – Omaha | \$5M | \$28 – \$35M |
| Research Expenditures Total | \$38M | \$84 – \$105M |
| Tenured / Tenure-Track Faculty | | |
| Tenured / Tenure-Track Faculty – Lincoln | 122 | 142 |
| Tenured / Tenure-Track Faculty – Omaha | 43 | 73 |
| Tenured / Tenure-Track Faculty Total | 165 | 215 |
| Research Expenditures - Faculty | | |
| Research Expenditures / T/TT Faculty – Lincoln | \$300,000 | \$400 - \$500K |
| Research Expenditures / T/TT Faculty – Omaha | \$100,000 | \$400 - \$500K |
| Research Expenditures / T/TT Faculty Total | \$237,500 | \$400,000 - \$500,000K |

Table II: Highlights of key changes by campus planned over the coming five years.

| | Omaha | Lincoln |
|-------------------------------------|-------------------------------------|-------------------------------------|
| Undergraduate student enrollments | + 400 | + 500 |
| Masters for working professionals | + 200 | + 100 |
| New bachelor's degree programs | Electrical Engineering | <i>none</i> |
| Organizational changes | Electrical and Computer Engineering | Electrical and Computer Engineering |
| New T/TT Faculty lines | + 30 | + 20 |
| Research Expenditures | + \$20-35M | + \$20-30M |
| Additional Faculty & Research Space | + 37,800 sq.ft. | + 25,200 sq.ft. |

need considerable attention and support from the Office of Research and Economic Development. We will have to create successful approaches to recruiting, selecting and developing new faculty. We will have to deepen our collaborations with IS&T and other disciplines in both Lincoln and Omaha. We will have to identify many new partners - throughout the State but especially in Omaha - in the K-12 districts, in the private sector and in the philanthropic community.

In order to achieve this vision, the College must draw on and strengthen its comparative advantages:

- Having campuses in both Lincoln and Omaha enhances opportunities to grow enrollment and to engage with the private sector. Offering students a choice of campus increases the range of students for whom we will be attractive. Being integral to both communities allows us to draw on the expertise of and partner with a wide range of industries.
- The enormous reputational potential of the Peter Kiewit Institute is key to the college's growth goals and to its long term reputation and relevance. The partnership with the College of Information, Science, and Technology within the umbrella of the Peter Kiewit Institute creates the potential for a more integrated approach to supplying the broad set of technology workers needed for the modern economy and a closer relationship with the private sector in Omaha.
- UNL's recent affiliation with the Big Ten Conference, a set of schools known for its strong engineering programs, not only allows the college to leverage this collaboration in teaching and research, but enhances the college's attractiveness to prospective faculty and students from across the country and the world.
- The unique set of private and public sector companies and institutions, largely in Omaha, including international engineering and construction firms, the University of Nebraska Medical Center, the prominence of agriculture and food industries, and STRATCOM create extraordinary opportunities for research addressing critical contemporary issues and for preparing students for careers in important industries.

- The Durham School has the opportunity to unify the various professions related to the construction industry and thus to reflect contemporary business practices in the industry. This creates enhanced opportunities for education and research, particularly with the number of leading construction companies located in Omaha and Nebraska.

Accomplishing our growth goals will require unprecedented but achievable levels of efficiency and success in all we do. But even if we greatly enhance efficiency, we will also require considerable new resources. There are human and capital resource needs in order to realize all of these goals. These needs are encapsulated in Table I by a net increase of 50 T/TT faculty over the next five years (over and above the estimated 50 replacement faculty that will need to be hired in the same time frame). The cost to hire 100 new faculty and to support and educate over 1000 additional students is manifest in faculty salaries, start-up equipment and infrastructure costs. There must be concomitant increases in student services, technician and administrative staff to support the growth plan. Table III below provides a broad estimate of the needs associated with our goals.

Growth will also produce new revenue that we can use to offset some of these costs. These are estimated in Table IV above. The key point from this table is that these are recurring revenues which over time will provide a significant long term return on investment. But funding gaps clearly remain. Even if no additional faculty growth were to occur after the five year period, there would be approximately 10 – 15 faculty departures, mostly retirements every year. While

Table III: Summary of additional resources required to implement the growth plan.

| Goal | Total Cost/Need | Omaha | Lincoln |
|--|-----------------|---------------|---------------|
| Hire 100 faculty, include 50 new lines: salary and benefits. (50 x \$100K; assume SVCAA waives reversion; plus \$1M for salary differential for senior hires) | \$6.5M | \$3.9M | \$2.6M |
| Faculty start-up. (assume \$500K per faculty hire) | \$50.0M | \$30.0M | \$20.0M |
| New staff lines w/ benefits (assume 30 new staff at \$52K average - in students services, business office, teaching lab support, IT, etc.) | \$1.6M | \$1.0M | \$0.6M |
| Renovate existing teaching labs and classrooms | \$5.0M | \$1.5M | \$3.5M |
| Renovate existing research labs | \$2.0M | \$1.0M | \$1.0M |
| Additional faculty office space (50 hires x 150 sq ft) | 7500 sq ft | 4500 sq.ft. | 3000 sq.ft. |
| Additional student support service personal/office | 1000 sq ft | 600 sq.ft. | 400 sq.ft. |
| Additional graduate students | 4500 sq ft | 2700 sq.ft. | 1800 sq.ft. |
| Additional faculty research labs | 50,000 sq ft | 30,000 sq.ft. | 20,000 sq.ft. |
| Additional classrooms | 60,000 sq ft | 30,000 sq.ft. | 30,000 sq.ft. |

Table IV: Summary of additional revenues derived from realizing enrollment and research growth objectives

| | Total | Omaha | Lincoln |
|---|----------------|---------------|----------------|
| Additional differential tuition | \$1.5M | \$0.67M | \$0.83M |
| Additional base tuition (range reflects fully in-state and fully out of state tuition for added undergraduate enrollment) | \$7.2M – 18.0M | \$3.2M – 8.0M | \$4.0M – 10.0M |
| Additional F & A | \$3.0M | \$1.5M | \$1.5M |

no additional salary costs would be incurred, there would be recurring start-up costs for new faculty hires. Most significantly, however, the funding for faculty start-up and building the necessary infrastructure to house the growing college are major costs that will require financial help from the NU system, the campus, the state and the engineering community of Nebraska to reach our goals.

Part II: Major Goals of the Growth Initiative

Ultimately, the task before the College is to develop high quality, high impact programs, both educational and research, that will address the most pressing and strategic needs of the State. And in so doing, we will garner the attention and respect of the nation. The College plays a vital role in creating a compelling sense of ‘pride of place’ that will make Nebraska a destination for bright engineering talent and industries into the future. In this section, we highlight a number of the programs and initiatives that are in various stages of development, from concept to implementation. The strong emphasis on Omaha with proportionate balance across Nebraska is an intentional foundation of these efforts.

II.1: Increase undergraduate and masters degree production

The demand for engineers worldwide is astounding. The Bureau of Labor Statistics projects a need for 1.5 million engineers by 2020 in the US alone. This is more than 10% higher than current numbers in 2010. The challenge for producing enough engineers to satisfy business demands is not isolated to Omaha or Nebraska; it is world-wide.

As such, our goal of increasing our annual B.S. production rate is critical to the competitive success of Nebraska. Specific elements of our action plan include:

Enhancing undergraduate recruitment.

- The UNO and UNL Admissions offices are now working together with collaboratively designed recruitment strategies. Cooperation between these two effective offices creates the basis for several other advancements, including the redesign of NeSIS to allow dual registration for PKI engineering students and seamless data reporting for UNO and UNL on both campuses.

- A full-time recruiter has been hired with specific responsibility for recruiting to College programs in Omaha.
- Recruitment staff in both Omaha and Lincoln will have to be increased in collaboration with UNL and UNO Admissions efforts.
- We will intensify outreach to groups of students not adequately represented in the STEM disciplines (women, minorities).
- The College of Engineering will partner with UNL's College of Education and Human Sciences and with Omaha metro school districts and others around the State to seek external funding for K – 12 based projects that increase student interest in engineering.
- We will continue to promote the GK12 Fellowship Program.
- An integrated recruitment plan for PKI will be developed to both capture the advantages of PKI but to assure that recruitment of students is a coordinated enterprise.
- An integrated plan for enhancing STEM education in K-12 will be developed within PKI to permit leveraging the full range of disciplines represented and to maximize the interactions with K-12.

Assuring educational programs are responsive to the workforce demands of Nebraska.

General workforce statistics suggest a national shortage of trained engineers. Focusing on the needs in Omaha or Nebraska must recognize this larger context. Nonetheless, the College recognizes its responsibility to be responsive, to the extent possible, to the major needs of the Nebraska private sector. The College has traditionally utilized an Industry Advisory Board that has advised the Dean and faculty on industry patterns, both in local regions and also nationally. However, good data on specific engineering disciplines is difficult to find. The college in collaboration with IS&T has engaged the Omaha Chamber to conduct a workforce need survey in Omaha to obtain a more refined understanding of the demand, and any shortage, of engineering graduates. This could serve as a pilot project that could be extended State-wide if successful.

Streamlining and restructuring the college's programs/offerings for more effective and efficient teaching and learning.

Eliminating redundancies in the college's programs, departments and activities will allow for greater use of our resources—faculty, staff, funding, etc.—while permitting growth and innovation in responding to the needs of Nebraska. Streamlining our organization will give students in both cities enhanced course offerings, opportunities to learn from faculty with diverse expertise areas, and additional interactions with one another, regardless of location. Among the specific proposals would be the following:

- Introduce Electrical Engineering as an undergraduate major in Omaha, by taking advantage of common courses for both electrical and electronic engineering curricula to permit more specialized courses needed for electrical engineering in Omaha.
- Merge Department of Computer & Electronics Engineering and Department of Electrical Engineering into one Department of Electrical & Computer Engineering effective 1 July 2014. Unify the two separately accredited and independently delivered Computer Engineering degree programs beginning 1 July 2014. This would permit more effective use of the faculty in both programs[†].

[†] This last bullet requires additional explanation. There are curricular, scientific, as well as administrative reasons for this action. From a curricular perspective, the electronics degree offered by CEEN is virtually identical to one of the concentration tracks within the EE degree program. Students in Omaha do not have the same breadth of

Creating full educational opportunities for Omaha and Lincoln students.

In order to build a vibrant College of Engineering student community, it will be necessary to virtually link our classrooms and student communities in Omaha and Lincoln. We will build state-of-the-art virtual classrooms to supplement our other course delivery methods. Deployment of the first inter-campus 'NUVIEW' classroom is anticipated in 2013. This will permit specialized courses offered on one campus to be accessible by students on the other campus.

Improving undergraduate retention and graduation rates.

Retention and graduation rates are currently at unacceptable levels. As previously noted, the College has graduated 400+ B.S. level engineering annually. In the past two years, this has increased to more than 450 each year; Table V shows graduation numbers by year and program appears on the following page. But the retention rates from the freshman to sophomore years in engineering are less than 70% in aggregate between Lincoln (~71%) and Omaha (~65%). Note that the overall retention rate of students entering the College returning for their sophomore year anywhere within UNL is 87%; this is above the UNL-wide retention rate of 84%. It is not surprising, then, that the six-year graduation rate in engineering has been ~44% over the past five years with an overall graduation rate (entering as an engineer but graduating with any UNL degree) of ~67%. By comparison, the UNL-wide six-year graduation rate is ~64%. The College has declared a goal to reach a 90% freshmen to sophomore retention rate in 5 years and to increase the six-year graduation rate in engineering to 70%. This improvement in retention coupled with enrollment increases should allow us to increase the annual number of B.S. degrees awarded in engineering to 630 annually.

Enhancing the freshman year.

- *Initiating first-year student interactions with industry:* It is clear that providing students with contemporary information about the career opportunities and connections to appropriate industries enhances retention and graduation rates as well as provides a basis for employment after graduation. It is also important to make students feel a part of the profession as early as possible in their educational careers.

options available to them as their counterparts in Lincoln. By bringing the full suite of EE offerings to Omaha, the students there will have a richer set of course options as well as the opportunity to interact with more faculty in a wider range of fields.

From a research perspective, faculty in CEEN are strong in telecommunications but not in other areas. In contrast, EE faculty have strengths in biomedical imaging, electronic materials, energy, etc, but no expertise in telecommunications. In addition, EE faculty do not have an infrastructure platform from which to collaborate with Omaha organizations such as UNMC and STRATCOM. Combining the two departments would create greater opportunities for collaboration between faculty in the currently separate departments, and it will create greater opportunities and synergies for all of the faculty with Omaha industry.

Finally, from an administrative perspective, the instructional resources necessary to independently run the electronics engineering and electrical engineering degree programs is inefficient, particularly on the faculty currently comprising CEEN. By bringing faculty from Lincoln to Omaha (either physically by commuting, or virtually by telepresence classroom technologies), faculty in Omaha will be able to better balance their efforts between teaching and research. It should be noted that the pre-existence of very similar programs on both campuses enables the introduction of the electrical engineering degree to Omaha. It will be prohibitively expensive and duplicative to essentially replicate any of the other departments which currently reside in only one location.

As a result of the CEEN / EE merger, there will be two independently accredited computer engineering degrees that will exist in Lincoln. This is another inefficiency that will have to be addressed. There are other instances where curricular alignment across programs and departments call for careful assessment and possible action.

- We will continue to enhance our N.U.B.E. Camp and introduce students to industry early in their college careers. In 2012, we began to invite industry representatives to participate in a session that informs incoming first-year students about career paths within their companies and allows those representatives to meet their future employees four years before the students graduate and go to work.

| | Architectural Engr (Omaha) | Civil Engineering (Omaha) | Computer Engineering (Omaha) | Construction Engr (Omaha) | Construction Managemnt (Omaha) | Electronics Engr (Omaha) | Agricultural Engineering | Biological Systems Engineering | Chemical Engineering | Civil Engineering | Computer Engineering | Computer Science | Construction Management | Electrical Engineering | Industrial Engineering | Mechanical Engineering | TOTAL B.S. GRADUATES |
|----------|----------------------------|---------------------------|------------------------------|---------------------------|--------------------------------|--------------------------|--------------------------|--------------------------------|----------------------|-------------------|----------------------|------------------|-------------------------|------------------------|------------------------|------------------------|-----------------------------|
| AY 1996 | | 20 | | | | | 12 | 19 | 24 | 36 | 15 | 22 | 35 | 41 | 16 | 62 | 302 |
| AY 1997 | | 9 | | | | | 9 | 21 | 21 | 55 | 11 | 37 | 59 | 41 | 13 | 52 | 328 |
| AY 1998 | | 14 | | | | | 9 | 13 | 18 | 46 | 20 | 34 | 53 | 42 | 21 | 46 | 316 |
| AY 1999 | | 14 | 3 | | | | 3 | 14 | 17 | 37 | 29 | 44 | 60 | 34 | 14 | 56 | 325 |
| AY 2000 | 5 | 12 | 8 | | | 6 | 6 | 19 | 20 | 36 | 32 | 46 | 56 | 35 | 18 | 72 | 371 |
| AY 2001 | 8 | 9 | 14 | | | 5 | 10 | 17 | 27 | 32 | 20 | 55 | 45 | 49 | 12 | 55 | 358 |
| AY 2002 | 14 | 16 | 19 | | | 13 | 5 | 19 | 19 | 42 | 34 | 56 | 69 | 39 | 13 | 60 | 418 |
| AY 2003 | 18 | 21 | 23 | | | 7 | 6 | 12 | 26 | 39 | 27 | 52 | 46 | 48 | 13 | 59 | 397 |
| AY 2004 | 25 | 26 | 17 | | | 6 | 9 | 12 | 14 | 37 | 22 | 55 | 62 | 43 | 21 | 55 | 404 |
| AY 2005 | 28 | 32 | 14 | | | 7 | 9 | 17 | 13 | 29 | 25 | 35 | 46 | 58 | 24 | 61 | 398 |
| AY 2006 | 29 | 27 | 26 | 1 | | 10 | 10 | 17 | 19 | 39 | 31 | 33 | 45 | 52 | 14 | 58 | 411 |
| AY 2007 | 31 | 25 | 15 | 2 | | 15 | 4 | 12 | 21 | 54 | 21 | 32 | 62 | 34 | 19 | 78 | 425 |
| AY 2008 | 39 | 28 | 16 | 8 | 11 | 18 | 4 | 26 | 18 | 25 | 17 | 24 | 69 | 42 | 17 | 68 | 430 |
| AY 2009 | 18 | 33 | 23 | 5 | 19 | 8 | 4 | 22 | 17 | 61 | 12 | 28 | 69 | 41 | 8 | 67 | 435 |
| AY 2010 | 47 | 39 | 24 | 13 | 22 | 17 | 9 | 33 | 18 | 34 | 19 | 33 | 59 | 44 | 15 | 67 | 493 |
| AY 2011 | 32 | 45 | 18 | 10 | 24 | 6 | 7 | 27 | 27 | 55 | 19 | 29 | 66 | 40 | 18 | 80 | 503 |
| AY 2012* | 32 | 41 | 7 | 10 | 22 | 19 | 6 | 30 | 28 | 44 | 24 | 33 | 33 | 34 | 16 | 72 | 451 |

* AY 2012 data do not include August 2013 graduates.

Table V: B.S. graduation data by program and year.

- We will continue to expand our very popular tours of Nebraska industries for freshmen. This is a program that was initiated in 2012 by the College's Advisory Board that saw ~400 first-year students touring industries in the Columbus area. This year's trip will take students from both Omaha and Lincoln campuses to Grand Island. Trips to other metropolitan areas are anticipated in future years that will result in a multiyear cycle.
- *Creating a freshman leadership/retention course* which will be delivered for the first time in the Fall 2013 semester. The premise of this course is that if a student wishes to become a leader in her/his career, she/he must first learn to lead her/himself. While these are essential skills in the workplace, they are also critical to student success and increased graduation rates.
- *Creating a freshman engineering tools and methodologies course* with an anticipated roll out in Fall 2014. This course is specifically targeted at providing incoming engineering students immediate access to the equipment and techniques of the engineering workplace. This includes measurement, machining, and wiring and diagnostics of circuits. The goal is to provide students with immediate hands-on experience to empower them in their design activities throughout their studies.

Providing students with essential non-technical skills necessary for immediate productivity in the workplace.

We are developing a "leadership, innovation, and impact" curriculum with industry partners as a first step in preparing future engineers for leadership within their professions and across society. It will be a university-industry-government collaboration intended to provide every UNL engineering student with exposure to career opportunities in engineering and training in aspects of professional or leadership development. We have initiated partnerships with DLR and ConAgra to develop pilot curricula, with initial course delivery anticipated for January 2014. It is anticipated that the bulk of this curriculum will be offered primarily in Omaha due to the strong industry base. We have hired a Professor of Practice (former consulting engineering industry V.P.) to lead initiative and will add more professors of practice who have deep industry experience to design and deliver the curriculum.

Increasing enrollments in Masters programs for working professionals.

This is a college-wide initiative to increase participation in engineering graduate programs. These programs will be directed both at enhancing the skills of practicing professionals as well as creating the research talent needed in Nebraska. A Master's program for working professionals will be built from existing non-thesis M.S. programs offered by the different departments. As with all similar programs across the nation, these will be 30 credit degree programs. Embedded within those programs will be the opportunity for students to take groups of courses focused on business, leadership, and manufacturing.

The college currently offers an on-line masters degree in Systems Engineering and we envision that critical elements of industrial engineering will be retained/reintroduced through these courses. Given the preponderance of working engineers in Omaha, we will headquarter this program in Omaha and the initial program development activities will be focused in Omaha. Over time we hope to deliver courses to working professionals in other areas such as Grand Island/Kearny, Columbus/Norfolk, and Scotts Bluff should there be sufficient demand.

Increase Ph.D. production as faculty research grows.

The expansion of research, described below, will require a significant increase in the number of Ph.D students in the College in both Omaha and Lincoln. In the pre-sequester federal budget,

tenured faculty at top research colleges of engineering build research programs with an average of four externally funded Ph.D. students. These universities typically provide support for an additional Ph.D. student per tenured/tenure-track faculty. For the College, this would result in an increase of 800 - 1000 in Ph.D. enrollments.

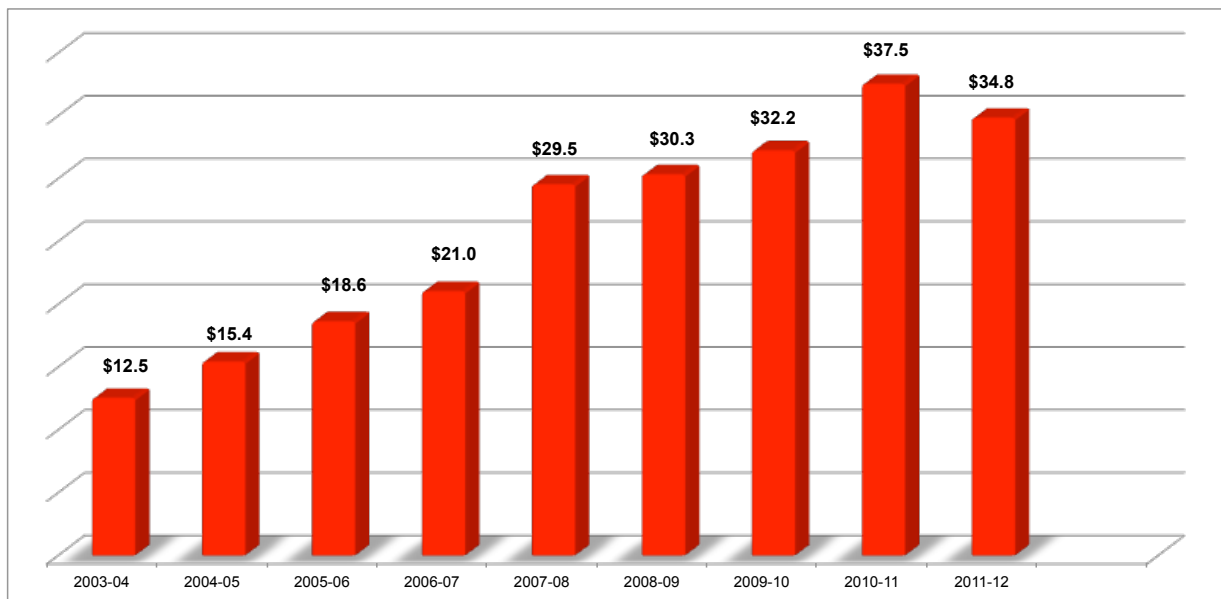
II.2: Increase Research & Development Productivity and Impact

In order to best support technology-based economic development in Nebraska, the College must maintain a balanced portfolio of research activities including:

- 1) *applied research and development* that addresses current industry need,
- 2) *translational research and development* to support industry leadership in the coming decade,
- 3) *basic research* to expand the scientific and engineering knowledge base upon which future technologies will emerge.

This is the segment of the College's portfolio with perhaps the greatest potential for dramatic improvement. As seen in the figure below, research expenditures have tripled over the last ten years to ~\$35M. But our colleagues in comparably sized colleges around the country that are ranked in the top forty have research portfolios that are twice again our current level of activity. And while the College has a good number of faculty who are internationally renowned in their areas of research, there are no collective areas of strength in which the College is perceived to be national or global leaders.

UNL College of Engineering Grant Expenditures/Commitments



There are two key factors contributing to the College's current state of research. First and foremost, a large fraction of the current faculty was not hired with expectations of building strong research programs. There is a culture change occurring in which both research *and* teaching at world-class levels for the benefit of Nebraskans is becoming the norm.

The second contributory factor is the sub-optimal engagement with Nebraska industry. This is most pronounced in Omaha where most of the State's industry base is concentrated. Strong collaborations with any of the broad industry sectors: food, transportation, and building, would place the College on the world stage. But we cannot be satisfied with one. We must partner with all of Omaha's industry groups.

The key venue for these partnerships is PKI. Over the coming years, we need to increase the number of Omaha-based engineering educators who are also research active. At the same time, we must create research spaces that enable faculty in Lincoln to more easily and effectively engage in research and development activities in Omaha. And we must, of course, create compelling world-class Omaha-centered R&D activities. By dramatically elevating the intellectual vitality at PKI (and indeed across the College), the College will truly transform into a single entity where current silos and divisions will disappear.

Examples of specific research and development initiatives that are being explored/developed are described in the following paragraphs.

IS&T – COE Collaborations on Civil Infrastructure and Construction.

The College of Information Science & Technology (IS&T) and the College of Engineering (COE) have initiated a preliminary planning exercise with the goal of building the types of collaborations originally envisioned to comprise the Peter Kiewit Institute. The core concept is to integrate the expertise in 'big data' and high performance computing from IS&T with physics-based disciplines in COE to address major technological challenges faced by industry of the State and beyond.

Two specific initiatives are being explored within this broad conceptual space: i) real time monitoring of civil infrastructure networks, and ii) real time monitoring of large construction projects. Both concepts entail the developing and deployment of ubiquitous arrays of sensors across a complex dynamic environment that will provide a constant stream of data to a centralized computer that will, in turn, provide analysis and modeling for real time monitoring, failure prediction, threat assessment, and, if necessary, disaster response.

Using the network of highway and railroad bridges across Nebraska (or indeed across the entire United States) as an example of big data applied to infrastructure, this program would address the challenge of developing low cost, reliable sensors for the structural members, the underlying supporting soil, bodies of water where they exist, traffic and weather to provide a data rich picture of the status of every bridge in the network in real time. There will be telecommunications challenges in transmitting data from all of these sensors to a centralized computer. From there, the computer will employ not only 'traditional' engineering modeling and assessment algorithms, but also 'big data' methodologies to search for statistical anomalies, and to recognize patterns that may indicate impending problems or threats. All of this must be done in real time, with critical outputs to the user base presented in simple, accurate and meaningful formats on inexpensive, standard devices such as smart phones or tablets.

The construction site (or demolition site) monitoring initiative will include much of the sensor array described above, but will also include sensors specifically targeted at human factors and performance data. The added dimensions that these sensors provide are the ensuring of worksite safety and overall project efficiency.

The vision is to build partnerships between IS&T and COE with industry (*e.g.* Union Pacific, Kiewit, HDR, *etc.*) and relevant government agencies (*e.g.* NDOR). Once clear objectives and roadmaps have been articulated amongst all the partners, the collective group will approach State and federal agencies to provide funding to sustain these efforts.

Manufacturing in Nebraska.

A major focus of the college's teaching, research and outreach enterprise in the coming decade will be on the three major industries of the state: manufacture of food, manufacture of civil infrastructure, and manufacture of equipment, devices and components. This is consistent with the priorities of the Nebraska Innovation Campus (NIC) and encompasses our major research centers including the Durham School, the Nebraska Transportation Center, and the Volte-Keegan Nano-science Research Center. The manufacturing focus is also consistent with our goal to make engineering education highly relevant and connected to 'real world' problems while providing students with the strong engineering science underpinnings.

- ***Manufacturing food:*** Our ultimate goal – which is significantly ambitious – is to create an Institute for Manufacturing Innovation (IMI) as part of the National Network for Manufacturing Innovation (NNMI). The University has already established a working relationship with ConAgra at NIC and discussions are ongoing to bring other companies into the partnership. The college has contacted other interested companies in Nebraska about the potential for building an IMI. The concept would be to leverage existing investments by the university, industry and state to equip and empower the food industry to make the same transformation in automation that the aerospace, electronics and automotive industries made over the past four decades. The goal is to place the university at the epicenter of designing the food factory of the future.
- ***Manufacturing civil infrastructure:*** One of the hallmarks of Nebraska industry is the manufacture of civil infrastructure. The state, particularly in Omaha, is home to some of the world's largest architectural engineering and construction firms supported by strong ties to the University of Nebraska system. Over the past two years, the college has intentionally refocused on the importance of this relationship. The public kick-off for the college's civil infrastructure initiative will be a workshop titled "Building the 22nd Century" to be held in Omaha 14 – 16 October 2013. In addition, the two PKI deans are currently developing a major collaboration between the College of Engineering and UNO's College of Information Science & Technology focused on the big data of real time monitoring and safety of construction (and demolition) sites, and the 'health monitoring' of civil infrastructure networks.
- ***Manufacturing equipment, devices and components:*** Underlying the manufacture of food and civil infrastructure is the manufacture of the equipment, devices and components needed for those industries. There is a network of advanced manufacturing companies across Nebraska producing a variety of products from center-pivot irrigation systems to truck trailers to grain storage bins to syringes. As an industry sector, this is more diffuse, but no less important to the economic development of both the rural and urban areas of the state. To this end, the col-

lege has joined in a proposal to the National Institute of Standards and Technology (NIST) to create a Manufacturing Extension Partnership (MEP) to provide engineering service and economic development support for Nebraska manufacturers. In addition, the college has just been invited to partner with the University of Illinois (the lead PI institution) on a proposal to the Department of Defense for an NNMI-IMI on digital manufacturing.

Expand collaborations between the College and UNMC.

It is mutually recognized that the national/international renown of both UNMC and the College of Engineering depends on a broad portfolio of collaborative research. Beginning in the summer of 2012, several team-building activities brought researchers from both institutions together. As the college continues through restructuring, we anticipate additional faculty will be hired and located in Omaha specifically to expand the breadth and quality of the biomedical research enterprise. The offices of research at both UNMC and UNL have partnered with the College in creating a seed funding program to accelerate research collaborations. At present, there are approximately thirty researchers from both organizations actively working to build collaborations leading to long term externally funded programs.

Build partnerships with STRATCOM through the new NSRI.

Partnerships with STRATCOM and the affiliated defense industries is an opportunity that has yet to be fully leveraged. Expertise on new materials, from conductive concrete to nanoparticles are being deployed in an initial set of collaborations in this arena. Additional areas of research and development possibilities include cyber-security and disaster/threat detection and mitigation. The DoD manufacturing institute mentioned above is a prime example of the types of opportunities that can arise through the NSRI arrangement. It is anticipated that by the beginning of the 2015 academic year, preliminary conversations with appropriate STRATCOM leadership to better articulate an R&D pathway that will again focus the College's activities on Omaha industries.

Partner with the Strategic Air & Space Museum (Nebraska).

Meetings with leadership at the Strategic Air & Space Museum in Ashland, Neb., have unveiled tremendous opportunities for collaboration with the college, from research through NASA EP-SCoR and the "leadership, innovation and impact" curriculum, to K-12 STEM and Native American outreach. This collaboration can create opportunities to expand the reach, relevance and impact of both organizations.

II.3: Increase tenure/tenure-track faculty

At the core of transforming the College will be the transformation of the faculty profile in which a passion for world-class research and technology innovation is layered on top of a fundamental commitment of outstanding engineering education. One cannot exist independently of the other. And indeed, the profile of all faculty currently being hired and who will be hired in the future will be an individual with a deep passion for serving others, with an excitement about cutting edge discovery and creation, who is just as passionate and excited about passing on all of these characteristics to future generations of engineers.

The selection of faculty will also be heavily driven by the initiatives and opportunities articulated in the preceding section on research and development. But at the same time, it is important to recognize the principle that quality trumps expertise. That is, a highly intelligent, creative, inno-

vative, team player who may not have worked in a particular sub-specialization that is a perceived need, can, in the long run, be far more productive and valuable than a less intellectually vibrant and engaged individual who happens to meet that particular niche of expertise. Over the life of the College, specific research and development foci will evolve. The College needs people with foundational expertise who can not only respond to, but who will drive the technological and economic evolution of Nebraska and beyond.

Within this context, the College anticipates a growth in tenured/tenure-track faculty size from the current 165 to 215 in 5 years. These faculty will be deployed with 72 in Omaha and 143 in Lincoln. This represents a growth of +30 and +20 in those two cities, respectively. When one considers that there will be a natural turnover of another fifty faculty in that time, in five years, roughly half of the College will be new. With development and retention of existing faculty, it is reasonable to expect that at least 75% of the faculty in the College will fit the profile described in the preceding two paragraphs. Dramatic increases in collaborations with industry in Omaha and across the State, and the enrollment of increasing numbers of highly qualified and capable students will be an organic byproduct of the faculty hiring initiative.

Key elements of faculty life in the College that will make us an academic employer of choice include:

- offering start-up packages averaging \$500,000 per tenure-track faculty hire. This is commensurate with start-up packages offered at the top research engineering colleges against whom we are competing for talent.
- maintaining an appropriate undergraduate:faculty ratio that allows faculty to provide individualized instruction and mentoring to our students and, at the same time, maintain the high profile research and development activities in which our students can engage.
- providing state-of-the-art facilities and equipment for both engineering education and research. There is an implicit expectation in this that faculty will have access to funds that will allow them to maintain and upgrade basic equipment for which external funds are not available.

III Implementation Timeline and Metrics

Up to this point, the focus of this document has been on articulating vision, framework, and opportunities for the College. This section contains tactical details and timelines associated with these initiatives. There are two elements to the future success of the College. The first is creating an efficient and effective organization capable of supporting the base education, research and service missions. The second is to developing unique, high-impact programs that elevate quality and establish national/international reputation. There will also be significant resources that will need to be brought to bear. The coupling of these components makes precise year-to-year planning difficult. The year-by-year metrics presented in graphical format, therefore, should be viewed as guideposts as opposed to rigid expectations. What is most important is that everyone work together to raise the intellectual vitality in the College and dramatically increase the quality of student training and service to the industries of Nebraska.

III.1: Increase undergraduate and masters degree production

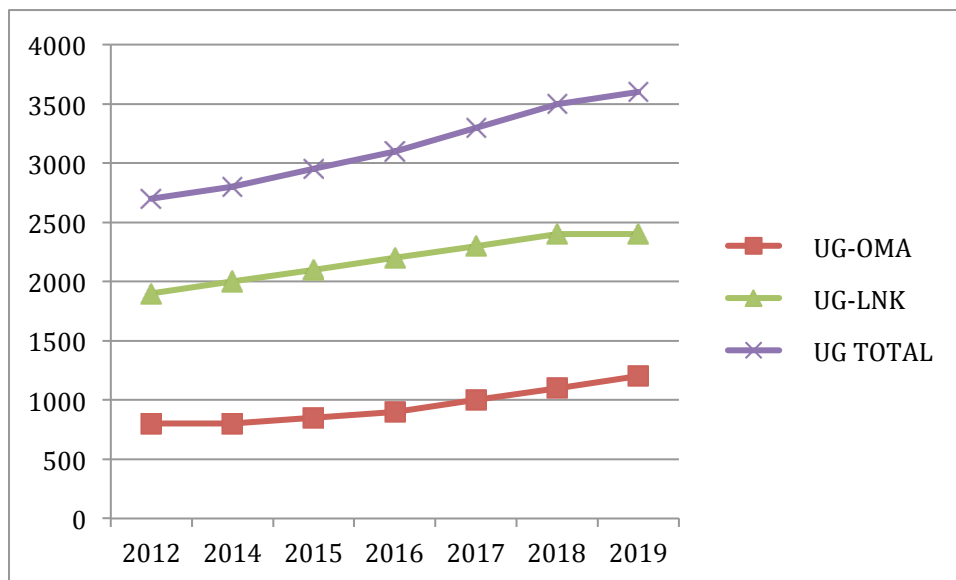
Enhancing undergraduate recruitment.

AY 2013 – 2014:

- UNO and UNL admissions professionals align recruitment activities of both COE and IS&T
- establish enrollment quotas for both Omaha and Lincoln campuses (to drive enrollments to available capacity in out years)
- tuition and scholarship investments are made to reflect changes in admissions and enrollment
- develop targeted recruitment plan for the College
- NeSIS refinements requested by UNO and UNL are enacted that allow all engineering students to be admitted to UNL but register for classes seamlessly at UNO or UNL. This facilitates cooperation between UNO and UNL admission recruiters and allows both campuses to track student data transparently.

AY 2014 – 2015:

- implement targeted recruitment plan for the College



Undergraduate enrollment projections reflecting an overall 5-year growth from 2700 to 3600.

Assuring educational programs are responsive to the workforce demands of Nebraska.

AY 2013 – 2014:

- charter Omaha Chamber study on workforce needs in Omaha
- engage industry state-wide in curricular assessment/revision/development discussions.
- Compose Omaha engineering advisory board to offer advice about college growth plan in Omaha.

AY 2014 – 2018:

- formally incorporate findings of Omaha Chamber study into ABET curriculum assessment and revision exercises

- formally incorporate results of industry curriculum meetings into ABET curriculum assessment and revision exercises.

Streamlining and restructuring the college's programs/offerings for more effective and efficient teaching and learning.

AY 2013 – 2014:

- introduce first Electrical Engineering courses in Omaha in Fall 2013.
- introduce electrical engineering degree as a program option in Omaha.
- develop merger plan for Departments of Computer & Electronics Engineering and Electrical Engineering into one Department of Electrical & Computer Engineering.
- develop plan to unify/integrate two independently offered Computer Engineering degrees.

AY 2014 – 2015:

- fully merged Department of Electrical & Computer Engineering begins formal operation on or before 1 July 2014.
- enroll first cohort of electrical engineering students in Omaha.
- a single fully unified Computer Engineering degree is offered in both Omaha and Lincoln.

Improving undergraduate retention and graduation rates.

AY 2013 – 2014:

- initiate new Director of Student services.
- reorganize student services offices in Omaha and Lincoln.
- initiate newly hired advising staff in Omaha and Lincoln.

AY 2014 – 2015:

- first year retention rate in Lincoln increases to 75%
- first year retention rate in Omaha increases to 70%

AY 2015 – 2016:

- first year retention rate in Lincoln increases to 80%
- first year retention rate in Omaha increases to 75%

AY 2016 – 2017:

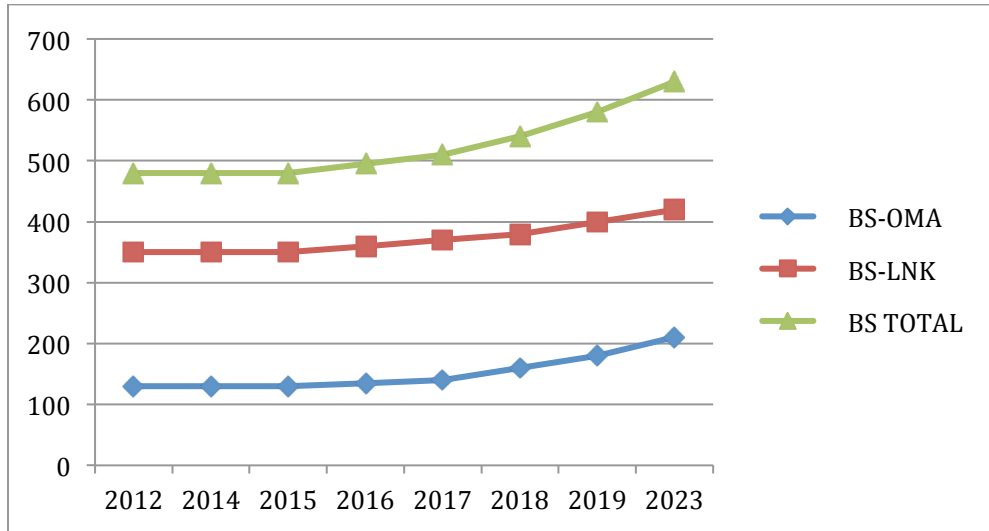
- first year retention rate in Lincoln increases to 85%
- first year retention rate in Omaha increases to 80%

AY 2017 – 2018:

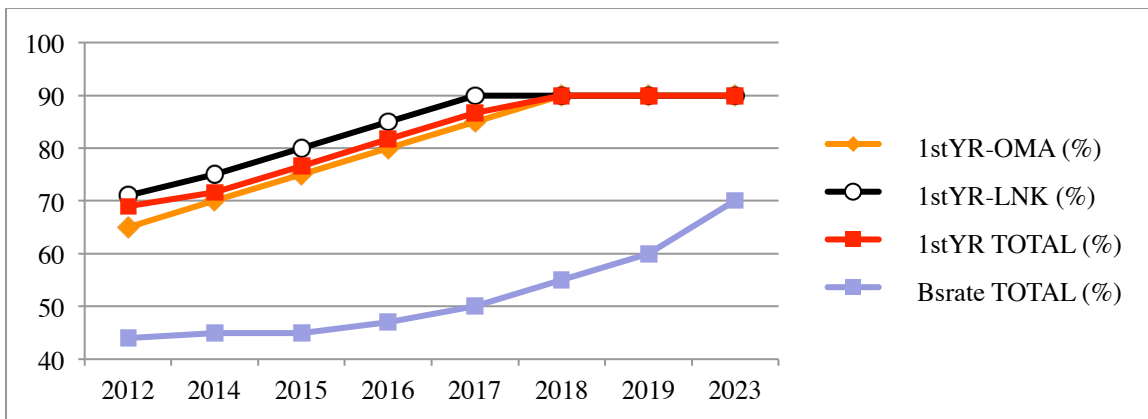
- first year retention rate in Lincoln increases to 90%
- first year retention rate in Omaha increases to 85%

AY 2018 – 2019:

- first year retention rate in Omaha increases to 90%



Projections for B.S. degree production over a ten-year period. This reflects the ten-year goal of increasing the six-year graduation rate in engineering to 70%.



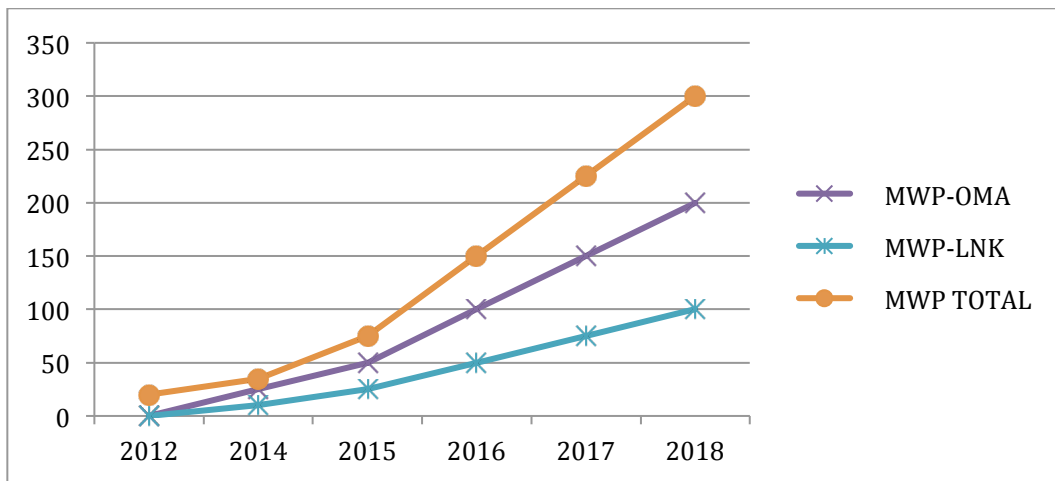
Projections for first-year retention rates in engineering over a five-year period. Also shown in blue is the goal of increasing the six-year graduation rate in engineering to 70% over ten years.

Enhancing the freshman year.

- *Initiating first-year student interactions with industry interactions:*
 - N.U.B.E. Camp and introduce students to industry early in their college careers. In 2012, we have begun to invite industry representatives to participate in a session that informs incoming first-year students about career paths within their companies and allows those representatives to meet their future employees four years before the students graduate and go to work.
 - We will continue to expand our very popular tours of Nebraska industries for freshmen. This year's trip will take students from both Omaha and Lincoln campuses to Grand Island. Trips to other metropolitan areas are anticipated in future years that will result in a multiyear cycle.

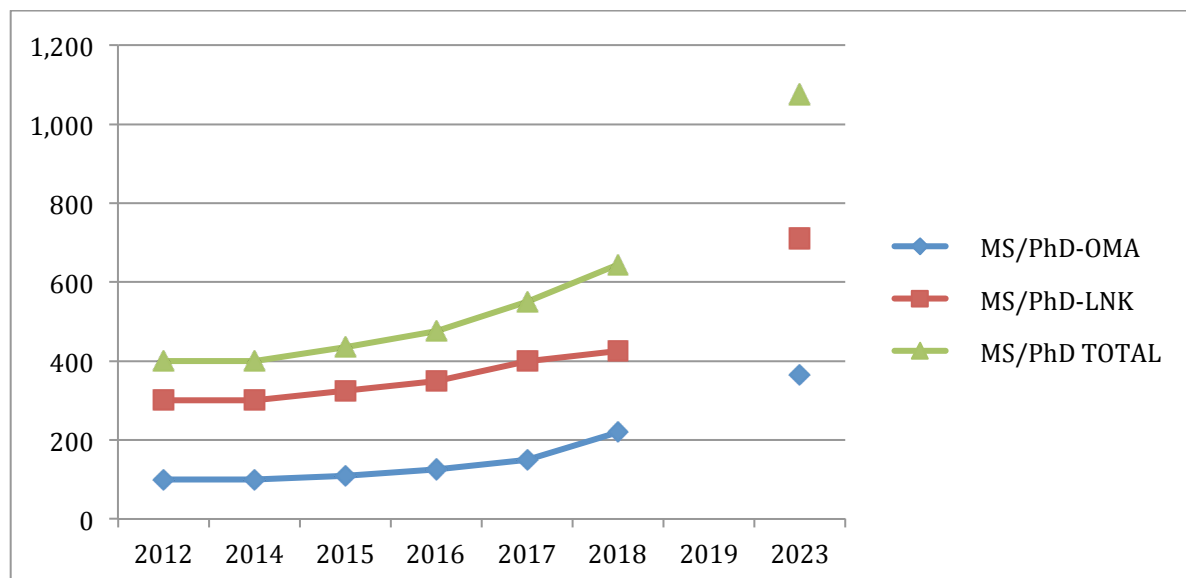
- *Creating a freshman leadership/retention course* which will be delivered for the first time in the Fall 2013 semester.
- *Creating a freshman engineering tools and methodologies course* with an anticipated roll out in Fall 2014.

Increasing enrollments in Masters programs for working professionals.



Projections for enrollment growth of the proposed masters degree program targeted at working professionals.

Increase Ph.D. production as faculty research grows.



Projections for Ph.D. graduate student enrollments over a ten-year period. This reflects the ten-year goal of increasing research funding and the concomitant increase in externally funded graduate students.

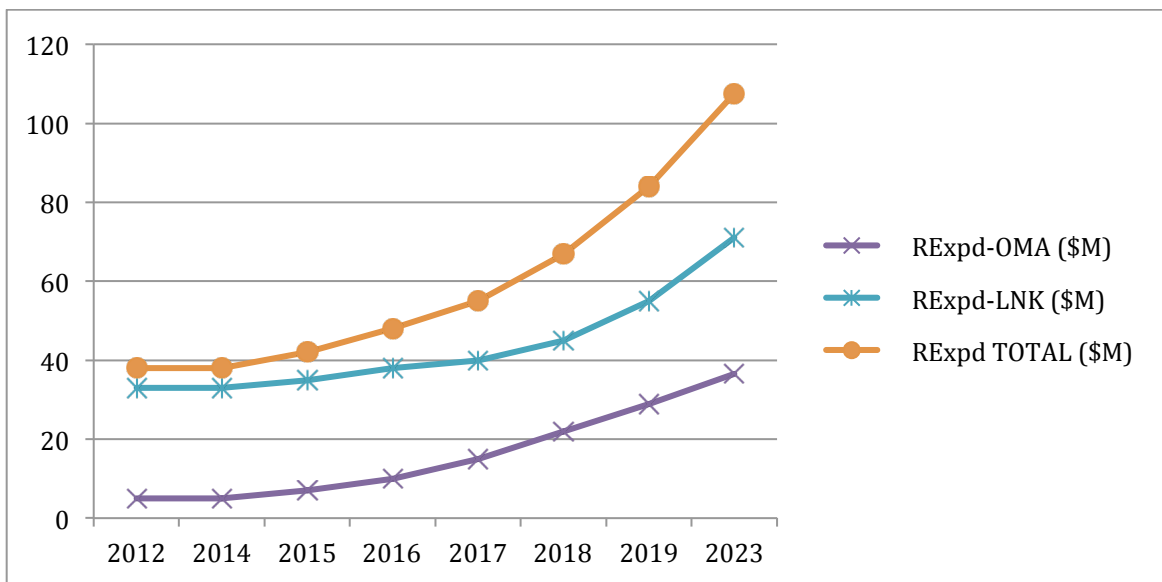
III.2: Increase Research & Development Productivity and Impact

Research expenditures: \$60 million by AY 2018; \$86M by AY 2023

Research expenditures per T/TT faculty (average and median): \$300K by AY 2018; \$400K by AY 2023

Archival publication rates: 3 per tenure/tenure-track faculty per year by AY2018

Ph.D. graduation rates: 0.4 per year per T/TT faculty by AY 2018; 0.75 per year per T/TT faculty by AY 2023



Projections for externally funded research expenditures over a ten-year period. These goals are predicated on a return of stability of federal research funding.

III.3: Increase tenure/tenure-track faculty

Year 1

Search for 10 new faculty; 6 in Omaha, 4 in Lincoln

Year 2

Add 10 new faculty; 6 in Omaha, 4 in Lincoln (total faculty increases to 175)

Search for 10 new faculty; 6 in Omaha, 4 in Lincoln

Year 3

Add 10 new faculty; 6 in Omaha, 4 in Lincoln (total faculty increases to 185)

Search for 10 new faculty; 6 in Omaha, 4 in Lincoln

Year 4

Add 10 new faculty; 6 in Omaha, 4 in Lincoln (total faculty increases to 195)

Search for 10 new faculty; 6 in Omaha, 4 in Lincoln

Year 5

Add 10 new faculty; 6 in Omaha, 4 in Lincoln (total faculty increases to 205)

Search for 10 new faculty; 6 in Omaha, 4 in Lincoln

Year 6

Add 10 new faculty; 6 in Omaha, 4 in Lincoln (total faculty increases to 215)

-- CONCLUSION --

In order for the University of Nebraska College of Engineering to realize the vision of expanding the state's (and nation's) engineering workforce and economic development, we must dramatically increase quality and productivity across all of our programs.

To accomplish this, the college will work to fundamentally change our organization, our mode of operation, and our outlook. This nexus of opportunity, commitment and leadership is being realized across the college, joined by a collaborative vision of faculty, staff, alumni, students, and others involved in our mission. The next five to 10 years will be one of transformation and excitement in both Omaha and Lincoln for the College.