

Greater Omaha Business Requirements for Educational Services in Engineering

A report compiled by the
Applied Information Management Institute



Curriculum Council

C.R. "Bob" Bell
Greater Omaha Chamber of Commerce

James Ingram
Leo A. Daly Company

Lee Kearney
Kiewit Construction Group

Elwin Larson
HDR Engineering, Inc.

Norman Nelson
Lyman-Richey Corporation

Curt Pendley
AMCI

Spencer Stevens
Applied Power Associates, Inc.

Lynden Tennison
Union Pacific Railroad Company

* * *

Advisory Committee

Daniel Dellovechio
Leo A. Daly Company

Hugh Morton
MSF Technologies

Dennis Murphy
Peter Kiewit Sons, Inc.

Table of Contents

	Page No.
I. Executive Summary	1
II. Background.....	3
A. Study Methodology	4
III. Findings.....	5
A. Employment and Training Budgets.....	5
1. Corporate Employment.....	5
2. Corporate Budgets	5
3. Engineering Employment	5
4. Engineering Budgets.....	5
B. Academic Disciplines.....	6
1. Most Important Academic Disciplines.....	6
2. Rank of Other Academic Disciplines	7
3. Engineering and Information Technology – A Note	8
4. Degree Levels	8
C. Applied Areas and Needs Met by Area University of Nebraska	9
1. Highest Ranked Applied Areas within Highest Ranked Academic Disciplines	9
2. Other High Ranked Related Areas.....	9
3. Needs Met by Area Universities.....	10
D. Technology Areas.....	11
E. Focus Groups	12
1. Comments about Survey Findings	13
2. Requirements of Engineering Education	13
3. Academic Disciplines and Delivery.....	14
IV. Conclusions.....	16
V. Recommendations.....	19
VI. Selected Bibliography.....	21
VII. Appendices.....	22
A. Number of Practicing Engineers in the Omaha Area	22
B. Demand for Engineers in the Omaha Metropolitan Area.....	24
C. Engineering Survey Participants	25
D. Survey Results	26

List of Tables

	Page No.
Table 1 Most Important Academic Disciplines.....	7
Table 2 Most Important Applied Areas.....	10
Table 3 Engineering Business Issues	12

Executive Summary

A survey of greater Omaha business requirements for educational services in engineering was completed by the Applied Information Management Institute.

This survey included 55 area employers with total employment of 16,125 employees.

Engineering employees totaled 1,866 or 11.68% of all employees in responding firms.

Other significant survey findings include:

- 1,255 or 7.8% of all employees from responding firms are currently taking academic courses.
- 70% of employees taking academic courses are in tuition reimbursement programs.
- Total training budgets for the 39 firms reporting these data are currently over \$5.4 million and projected to exceed \$6.9 million in five years (only 37 firms provided five-year budget estimates).
- For firms reporting these data, the per-employee training cost is:

	1995	Five Years
All Employees	\$ 659	\$ 769
Engineering Employees	\$1,357	\$1,613

The estimated total engineering employment for the metropolitan Omaha area is between 3,300 and 3,800.

Numerous additional conclusions are appropriate:

- Engineering positions will grow at about the same rate (25.3%) as all employees (22.9%).
- The number of new engineering graduates from state university campuses is less than the demand for such employees by metropolitan area firms.
- There is little evidence the shortfall in the availability of baccalaureate and master level job applicants will be corrected in the near term, forcing ongoing major recruiting efforts from outside the region.
- A strong demand for educational services exists at both the undergraduate and graduate level.
- The strongest demand for curriculum and programs included:
 - Civil
 - Construction/Architectural
 - Structural
 - Electrical/Computer
 - Environmental, Sanitary, Geotechnical, General
 - Electrical/Power
 - Mechanical
- Information technologies have a substantial electronic engineering dimension to them.

- The integration of information technologies into structures, products, devices, and processes is leading to an applied convergence of most information technologies and many engineering disciplines.
- Local delivery of educational services is highly preferred to distance learning technologies. If distance learning technologies are employed, firms are inclined to seek the “best” providers available nationally.
- Combined industry trends toward increased requirements for annual license renewal plus validation of professional continuing education programs may create training opportunities for universities.

Recommendations

1. Business has the opportunity to directly influence academic programs by:
 - creating partnerships between business and academia to partly fund key faculty positions and research while bringing highly qualified individuals to the community.
 - further defining specific needs in the Academic Disciplines and Applied Areas identified as most important in this study.
 - working with universities and area high schools to develop creative programs that attract more students to close the gap between demand for and supply of engineering graduates.
2. Area universities may wish to:
 - create a vision for engineering that serves traditional markets while anticipating the convergence of information technology into the structures, devices, and processes of the future.
 - Develop high quality, locally available, and comprehensive baccalaureate and graduate programs in:

Civil Engineering	Electrical/Power	Electrical/Computer
Mechanical	Construction/Architectural	
 - Tightly align electronic engineering programs with information technology to support the continued convergence of these disciplines.
 - Aggressively seek the intellectual resources required by the integration and convergence of engineering disciplines and information technologies.
 - Develop creative courses and marketing programs that target students seeking master degrees who are employed by firms with tuition-reimbursement programs.
 - Establish techniques to partner with business.
 - Develop techniques to allow greater mobility of academic resources and collegial partnerships across campus boundaries.
 - Develop incentives to encourage faculty training and re-training into engineering disciplines demanded by area/state businesses.
 - Develop a vision and plan to provide continuing educational services to area engineers and their employers.

Background

There has been much discussion about engineering educational services required by the greater Omaha business community. With engineering labor markets tight (unemployment at 2.65% nationally in 1st Qtr '95)¹ and continued growth of greater Omaha firms, the demands for educational services will increase significantly.

Greater Omaha's unique position of having several engineering firms with national and international customers causes Omaha to have a disproportionately high requirement for engineer professionals. Estimates of engineering employment, not including architects, in the metropolitan area range from 3,300 to nearly 3,800 (Appendix A).

No matter which estimate is used, the number of new graduates from the university system is well below the needs for the business community which is experiencing a normal 5-7% growth rate for engineers. Appendix B shows an estimated annual shortfall of 190-220 engineers with baccalaureate degrees. The annual demand for 110-130 postgraduate engineers (both new hires plus current employees who seek a masters or doctorate while employed) will also exceed the number available from the university engineering departments based on historical placement records.

The demand for educational services takes three basic forms:

- Baccalaureate graduates to fill entry-level positions
- Graduate programs for existing employees
- Continuing education required for:
 - registration
 - annual renewal of registration
 - general and specific training for professional growth.

A further dimension of the emerging market for practicing engineers is the convergence and integration of information technologies into historical engineering disciplines. To illustrate, Union Pacific "wired" their entire network of tracks managing traffic, rolling stock, crews and freight services from their Omaha Harriman Dispatch Center. MFS Network Technologies' engineers are creating "smart" toll systems for toll roads providing vehicle identification at expressway speeds with monthly bills sent to users. Information technologies will increasingly be used to create "smart" structures, devices, and processes.

In addition, information technologies are increasingly being used by engineering itself. Design, modeling, simulation, networked collaboration techniques, and other such technologies will only increase in the future.

¹ Engineering News Record, July 1995, page 45.

These forces are combining to make Electrical/Computer engineering a fast-growth discipline in the greater Omaha market. The demand is coming from both traditional engineering companies and non-engineering companies that require these academic skills to achieve business objectives.

This discussion suggests that the emerging issues may not just be the local availability of engineering courses and programs. There may also be a gap between future market expectations and the deliverables from Nebraska engineering programs.

To help bring a sharper focus on business needs, the Applied Information Management (AIM) Institute has completed an extensive study of engineering-based educational service needs of greater Omaha business. The following summarizes the findings of this study. The results are designed to provide an informed and documented statement of need to academic institutions. It will also be instructive in helping area businesses evaluate their operations and focus their expectations from local educational providers.

A. Study Methodology

The study was directed by an Engineering Curriculum Council composed of senior engineering and business managers from Omaha businesses. A questionnaire was designed to document Omaha firms' present and future requirements for employment, training budgets, and curriculum needs of greater Omaha area employers. These questionnaires were mailed to greater Omaha employers that provide engineering services to their customers or use engineers to meet their business objectives.

The study methodology helps sharpen the focus on academic disciplines required by area businesses. It also helps quantify market size and training budgets. While the results probably understate training budgets for respondents, it provides a good insight into emerging demand for educational services.

Not all respondents provided rankings as requested by the questionnaire. Therefore, composite rankings for Academic Disciplines, Applied Areas, and Business Issues are a weighted-average, computed as:

$$\frac{\Sigma \text{ Number of Engineers Employed by Respondents Who Ranked the Issue } \times \text{ Rank}}{\Sigma \text{ Number of Engineers Employed by Respondents Who Ranked the Issue}}$$

Findings

A. Employment and Training Budgets

1. Corporate Employment

Survey forms were completed by 55 firms.

Survey results represent firms with 16,125 employees in the Omaha Metropolitan Area.

During the next five years, employment is expected to reach 19,800 - a 23% growth.

1,255 or 7.8% of present employees are currently taking academic courses for credit.

70% of these employees were on company tuition reimbursement programs.

Firms believed that over 1,920 or more than double the employees currently enrolled should be taking academic credit courses.

2. Corporate Budgets

39 of the respondents reported their training budgets. The total training budgets for these firms was over \$5,453,300, or \$659 per employees.

While only 37 firms provided training budget estimates for five years hence, these training budgets are projected to increase over 27% to \$6,939,000 or \$770 per employee.

Today, 30% of that budget is used for internally-provided training with the balance going to external seminars and workshops (51%), college tuition (18%), and other (1%).

In five years, internal training budgets will increase to 35% of the total training budget, compared to 48% going to external training seminars, 16% for tuition for college courses, and 1% for other.

3. Engineering Employment

Engineering employees total 1,866 or 11.6% of all employees, with engineers increasing slightly to 11.8% of the employee base in five years.

The five-year growth of engineering employees is projected at 25.3% compared to 22.9% for all employees.

9.5% of all engineering employees are taking academic credit courses; somewhat above the rate for all employees.

95% of these engineering employees were on college tuition reimbursement programs.

4. Engineering Budgets

Total engineering training budgets for the 33 firms reporting training budgets were \$1,969,000. The five-year engineering training budgets for the 31 firms providing these data are projected at \$2,783,700 - an increase of over 41%.

For firms reporting the data, engineering training averaged \$1,359 per employee and is projected to increase to \$1,617 in five years. While engineering employees account for 11.6% of all employees, engineering accounts for 36% of the training budgets. That is expected to grow to over 40% in five years.

B. Academic Disciplines

Respondents were asked to rank specific *Academic Disciplines*. They were also asked to report the number of employees in each discipline and project their requirements five years hence. They also reported on the percent of registered engineers in each Academic Discipline. Finally, respondents were asked to estimate what percent of their workforce had educational achievement at the baccalaureate or graduate level.

In this survey thirteen Academic Disciplines were considered, including:

- Aerospace
- Agricultural
- Chemical
- Civil –
 - Structural
 - Environmental, Sanitary, Geotechnical, General
- Construction/Architectural
- Electrical Power
- Electrical/Computer
- Environmental
- Industrial/Manufacturing
- Mechanical
- Mining
- Nuclear
- Petroleum

1. Most Important Academic Disciplines

The survey data shows that the greatest numerical growth in corporate employment will be concentrated in Civil, Construction/Architectural, Electrical/Power, Electrical/Computer, and Mechanical. Total engineering employment for the survey participants is expected to grow by 25.3% or 472 new employees in the next five years.

When asked to rank the above thirteen Academic Disciplines, the same five disciplines were tightly ranked as most important. Table 1 shows composite ranking, employment, and percent registered engineers for each academic discipline. These findings are consistent with the June 1991 study, “A Report of Engineering, Scientific, and Technical Companies,” by M. Ross Boyle.

“At the bachelor’s level, three-year demand is projected to be strongest for civil engineers, electrical, mechanical and computer engineers. Five-year demand is strongest for civil engineers, electrical, mechanical, and computer engineers.

At the master’s degree level, three- and five-year demand is projected to be strongest for electrical, computer, architectural and mechanical engineers.”

Table 1
Most Important Academic Disciplines for Employers of Engineers

	Rank*	Current Employment	Employment in 5 Years	% Change	% Reg'd Engineers
Civil – Structural	1.91	244	301	23.4	48.0
Civil – Environmental, Sanitary, Geotechnical, General	1.87	343	367	7.0	65.6
Construction/Architectural	1.98	229	313	36.7	33.6
Electrical/Computer	1.88	371	546	47.2	0.8
Electrical/Power	1.81	225	323	43.6	19.1
Mechanical	1.82	234	285	21.8	32.5

*Rank 1=Most Important 4=Least Important

These six Disciplines account for 88% of the present engineering employment for all respondents. Electrical/Power was ranked Most Important (1.81).

The combined Civil/Engineering Discipline (Structural plus Environmental, Sanitary, Geotechnical, and General) has a total employment of 587 that is expected to increase to 668. 58% of these Civil Engineers had professional registration.

Electrical/Computer has the fastest rate of growth for engineering employees.

2. Rank of Other Academic Disciplines

Academic disciplines ranked as least important to Omaha employers are shown below. Total engineering employment by survey respondents was relatively low for these additional engineering disciplines. The data shows modest five-year growth in employment in these disciplines.

Employment			
	Rank*	Now	Five Years
Aerospace	3.79	1	4
Agricultural	3.93	3	6
Chemical	2.93	22	29
Environmental	2.20	67	80
Industrial/Manufacturing	3.01	39	55
Mining	4.00	10	13
Nuclear	3.32	27	24
Petroleum	3.97	0	0
Other	--	50	0
Totals		219	263

*Rank 1=Most Important 4=Least Important

3. Engineering and Information Technology - A Note

The demand in this discipline seems to be rooted in several places.

- Computers and related information technologies are becoming increasingly important to the practice of engineering. Computer-aided design, modeling, and other technologies place increased training and skill requirements on practicing engineers from all disciplines.
- Information technologies are increasingly being designed into structures, devices, and processes. Structures such as medical facilities, schools, and business are being redesigned around present and future capabilities of information technologies. At a minimum, wiring and other physical needs of information technology must be designed into new structures. More important, however, the increasing demand for “smart” structures and devices will accelerate the demand for electronic engineering/computer skills.
- Classic business users of information technologies also have an increasing demand for personnel rooted in electrical engineering/computers. In colleges and universities across the country, the intellectual roots for information technology curriculums are frequently found in three colleges:
 - Engineering
 - Business Administration
 - Liberal Arts (usually the Math Department)

In the Omaha Metropolitan Area, most academic programs for information technology have a strong business or liberal arts heritage. Electronic engineering-based computer courses or programs are generally not available at area colleges or universities.

4. Degree Levels

For all firms, 81% of all engineering employees held baccalaureate degrees. The remaining 19% held graduate degrees. Aside from internship positions, virtually all firms require degrees in-hand before employment offers are made. As mentioned elsewhere in this report, this creates a strong demand for both local undergraduate and graduate programs – undergraduate programs to swell the ranks of locally educated engineers and graduate programs for continued advancement after their employment.

Of the firms that reported the data, 178 of their engineering employees, or 9.5%, were taking academic courses. When asked “the number of engineering employees you feel should be taking academic courses?” they reported 402, an additional 224 students.

If 402 engineers were enrolled, it would represent 21.5% of the engineering workforce.

As noted earlier, secondary data suggests there are between 3,300 and 3,800 engineers in the metropolitan area. If all employers’ needs matched the survey respondents, these data translate to a potential student base of 710-810, including both:

- Engineering employees now enrolled
- Engineering employees firms believe should be taking courses.

This represents a sizable unmet market demand that might respond well to creatively designed and targeted baccalaureate and graduate programs presented locally for currently employed engineers.

C. Applied Areas and Needs Met by Area Universities

Respondents were asked to rank specific Applied Areas within each Academic Discipline. In addition, they were asked to rank how well area universities were meeting their needs in each Applied Area. Values shown in this report are weighted averages based upon:

$$\frac{\sum \text{Number of Engineers Employed by Respondents Who Ranked the Applied Area} \times \text{Rank}}{\sum \text{Number of All Engineers Employed by Respondents Who Ranked the Applied Areas}}$$

The ranking scale was: 1=Most Important, 4=Least Important. The midpoint value on such a scale would be 2.50. The total number of Applied Areas in the survey was 92.

1. Highest Ranked Applied Areas within the Highest Ranked Academic Disciplines

Table 2 shows the 35 Applied Areas that ranked 2.5 or better within the five key Academic Disciplines.

2. Other High-Ranked Applied Areas

Of the eight Academic Areas judged of lesser importance by survey respondents, there were six Applied Areas that scored 2.5 or better. All were within the Academic Disciplines - Environmental. Those six Applied Areas are:

Other High-Ranked Applied Areas			
Applied Areas	Importance to Your Firm*	Need Met by Area Colleges/Universities	Difference
Environmental			
• Emissions/Effluent Control	2.26	2.41	-0.15
• Solid Waste Handling/Recycling	2.14	2.47	-0.33
• Water/Waste Water Treatment	1.89	2.28	-0.39
• Hazardous/Toxic/Radioactive Waste Management Cleanup	2.31	2.68	-0.37
• Impact Assessment Studies/Statements	2.38	2.73	-0.35
• Underground Storage Facilities/Tanks	2.49	2.81	-0.32

*Rank 1=Most Important 4=Least Important

3. Needs Met by Area Universities

Of the 32 Applied Areas that scored 2.50 or higher, the respondents judged the university as not meeting their needs in 23 of the areas. Conversely, the university is credited as meeting the need in nearly all Applied Areas judged to be of lesser importance by survey respondents.

Table 2
Most Important Applied Areas within Key Academic Disciplines
55 Firms

Academic Disciplines ● Applied Area	*Importance to Your Firm	**Need Met by Colleges & Universities	***Differences
Civil			
● Structural	1.63	1.89	-0.26
● Construction	1.91	2.29	-0.38
● Geotechnical	2.02	1.91	0.11
● Transportation	2.41	2.42	-0.01
● Infrastructure/Utilities	1.66	2.19	-0.53
● Surveying	2.34	1.85	0.49
Construction/Architectural			
● Building Structures and Foundation	1.97	1.74	0.23
● Heating, Ventilating and Air Conditioning	2.09	2.29	-0.20
● Plumbing/Drainage systems	2.30	2.29	0.01
● Fire Protection Systems	2.10	2.20	-0.10
● Lighting Design and Application	2.13	2.47	-0.34
● Building Electrical Systems	2.09	2.18	-0.09
● Cost/Quality/Time Management	2.14	1.78	0.36
● Environmental Control Systems	2.25	2.31	-0.06
● Process Piping	2.27	2.43	-0.16
Electronic/Computer			
● Computer Systems/Architecture	2.13	2.44	-0.31
● LAN/WAN Networks, Architecture and Design	2.22	2.31	-0.09
● CAD/CAM and Other Industry Design and Manufacturing Technology	2.15	2.04	0.11

*Rank 1=Most Important 4=Least Important

**Rank 1=Meets Needs 4=Does Not Meet Needs

***A positive value suggests needs are not being met. A negative value suggests needs are being met.

Academic Disciplines ● Applied Area	*Importance to Your Firm	**Need Met by Colleges & Universities	***Differences
Electrical/Power			
● Low Voltage Signal Communications Systems	2.28	2.28	0
● Control Systems	2.28	2.28	0
● Electric Power (emergency/standby/cogeneration/ prime power generation and distributing)	2.07	2.26	-0.19
● Electric Materials and Equipment	2.31	2.44	-0.13
Mechanical			
● Fluid Power and Control	2.28	2.37	-0.09
● Power Generation	1.91	2.35	-0.44
● Engineering Measurements and Instrumentation	2.40	2.14	0.26
● Heat Transfer/Energy Systems	2.04	2.26	-0.22
*Rank 1=Most Important 4=Least Important			
**Rank 1=Meets Needs 4=Does Not Meet Needs			
***A positive value suggests needs are not being met. A negative value suggests needs are being met.			

D. Technology Areas

There is an array of engineering business issues that transcend the various Academic Disciplines and Applied Areas. In many cases they are emerging issues within engineering. These business issues will provide focus to any of the Academic Disciplines and Applied Areas.

Table 3 shows engineering business issues that respondents ranked as most important with scores ranging between 1.0 and 2.0 today or in five years. These business issues are grouped into four classes:

- Personal Characteristics/Skills
- Project Management
- Business Development and General Management
- Industry Standards and Regulations

Business Ethics, ranked at 1.09, was the most important. With 1.0 as the highest possible score, 1.09 suggests nearly every respondents ranked this issue as most important.

Respondents seem to be saying that any academic program at the bachelors or masters level that does not provide some business focus will be lacking. These topics also provide fertile ground for continuing education programs and seminars.

Table 3
Engineering Business Issues
55 Firms

Business Issues	Currently	In Five Years
Personal Characteristics/Skills		
• Professional Ethics	1.09	1.09
• Preparation/Maintenance re:		
○ Professional Registration	1.97	1.68
○ Specification/Technical Report Writing	1.79	1.59
Project Management		
• Life Cycle cost analysis	1.85	1.59
• Client/Engineering Management	1.77	1.29
• Quality/Assurance Management Programs	1.70	1.55
Business Development and General Management		
• Business Development/Marketing	1.62	1.24
• Employee Recruitment and Retention	1.38	1.37
• Contractual Law and Responsibilities	1.96	1.68
• Industry Computer Software	2.06	1.84
• Technology Transfer	1.99	1.83
Industry Standards and Regulations		
• Industry Codes and Standards (ISO, ASTM, UL, ANSI, UBC/BOCA, Federal, Military, etc.)	1.85	1.82
• Regulatory Impacts (OSHA, EPA, ADA, etc.)	1.70	1.65
• Safety	1.57	1.46
• Hazardous Waste Management/Regulation	2.06	1.86

**Rank 1=Most Important 4=Least Important*

E. Focus Groups

Survey respondents were asked if they would like to participate in a Focus Group discussion.

A Focus Group Meeting held on October 10 included three questions:

- What is your reaction the survey findings?
- What are the requirements for engineering education at your firm?
- In which academic disciplines would you like to see baccalaureate and graduate degrees offered? How should these programs be delivered?

The meeting was led by a professional facilitator. Business leaders were the primary participants.

1. Comments about Survey Findings

Business participants concurred with the statistical findings of the surveys. Typical comments about the results included:

“No surprise – key message has been documented in other community studies.”

“Surprised at the strong showing of Electronic/Computers. It documents integration of information technologies and some engineering disciplines.”

“Will need to invest more for in-house training.”

“Tells me we must continue to hire from outside the area.”

“How do we maximize the impact of this study?”

“We are considering setting up a remote engineering lab because we can’t get enough engineers here.”

2. Requirements for Engineering Education

In addition to the lack of locally available baccalaureate and graduate programs in key disciplines noted below, comments about requirements for continuing engineering education clustered around two major needs:

- Professional Registration
- Specific Training

At both the individual and corporate levels, professional registration is becoming more important. CAD and other computer-based technologies allow engineers to assume more complete responsibilities of a design project. This reduces the number of draftsmen and others involved. As one participant noted, “The drafting table is where you put the computer.” The result is the ratio of registered engineers to all professionals is increasing. And, from a career perspective, graduate engineers are increasingly motivated to become registered.

Professional engineering societies, rather than academic institutions, have taken the lead in providing the courses/seminars and coaching to prepare for the examinations to become registered. In addition, these societies provide the materials and educational opportunities to support annual renewal of licenses.

Iowa and other states have increased requirements for license renewal. There is also an emerging trend to validate the quality of programs offered. These developments provide an opportunity to engineering schools. They also create increased inconvenience for practicing engineers with poor access to such programs.

For specific training, firms are increasingly bringing in professional training companies to address specific topics. In addition, they are using the training services of product and service vendors. While this trend may be satisfactory for the firm, it may represent a lost opportunity to the university that frequently has the labs and expertise to provide such services.

3. Academic Disciplines and Delivery

The Academic Disciplines reported as most important in the body of this report were also viewed as most important by the Focus Groups. Those included:

- Civil
- Electronic/Computer
- Electronic/Power
- Mechanical
- Construction/Architectural

The top priority was local availability of academic programs offering degrees in these disciplines.

Most firms have policies to hire only engineers with a baccalaureate degree. This leads to an important discussion of the appropriate degree level a local university should offer.

The data suggests that there is a shortage of local new engineering graduates. This forces the firms to employ from outside the region. Local undergraduate programs to educate more engineers is an appropriate solution. This would fill needs for area students and firms alike.

Student internships are viewed favorably and would grow if there were more students available to area firms. Salaried faculty internships were also viewed as a favorable way for faculty to address applied issues and remain in touch with the applied dimensions of their field.

Once an engineer is hired, however, the focus immediately shifts to graduate programs. Since most firms only hire employees with baccalaureate degrees, the ongoing professional need from both the firm and the employee standpoint is for graduate programs.

Many engineering candidates have rejected area employment offers because of the absence of advanced engineering courses available locally.

It will probably take both undergraduate and graduate programs to meet the needs of greater Omaha business. A full baccalaureate program must be included to:

- Increase the number of engineering graduates.
- Build the student base for graduate students.
- Sustain sufficient faculty for:
 - Undergraduate teaching,
 - Graduate teaching,
 - Research and business consultation, and
 - Community courses/programs including engineering courses required for professional registration.

Local delivery of academic programs are highly preferred. More night classes should be available. Creative solutions that provide course offerings that recognize different intensities in working schedules and other needs of students would encourage enrollments.

Satellite delivery or other distance learning technologies are a distant second choice, but superior to no local opportunities. If a firm goes to satellite courses, options like the National Technological University appear to be more favorable because of the breadth of their degree offerings with courses from over 50 participating universities across the USA. As such choices are employed by more Nebraska firms, competition for CorpNet may intensify. A focus on wise use of university resources will be required in an increasingly competitive educational services market.

Laboratory access is a major inconvenience to courses offered by distance learning technologies. Universities may wish to contract laboratory facilities and lab instructors to area firms with students taking courses via distance learning technologies.

Finally, the graduate degrees that provide increased engineering competencies with a management dimension were encouraged. This position was summarized by the statement:

“Engineers are

- Hired for their technical skills;
- Fired for their lack of interpersonal skills;
- Promoted for management skills.”

This understanding, combined with importance assigned to the engineering business issues (Table 3) earlier makes a compelling argument for a Masters in Engineering Management.

Conclusions

The Engineering Survey included 55 area employers with total employment of 16,125 employees.

Engineering employees totaled 1,866 or 11.6% of all employees in responding firms.

Other significant survey findings include:

- 1,255 or 7.8% of all employees from responding firms are currently taking academic courses.
- 70% of employees taking academic courses are in tuition reimbursement
- Total training budgets for the 39 firms reporting data are currently over \$5.4 million and they are projected to exceed \$6.9 million in five years (only 37 firms provided five-year budget estimates).
- For firms reporting these data, the per-employee training cost is:

	1995	Five Years
All Employees (39 firms reporting)	\$ 659	\$ 770
Engineering Employees (33 firms reporting)	\$1,359	\$1,617

With only 39 of the 55 respondents providing total firm training budgets and 33 providing engineering training budget information, the values reported above will substantially understate the total training budget of all survey firms.

The study methodology will not allow use of above values to develop estimates of total community engineering training budgets and total engineering employment. However, estimates from secondary data sources show total Omaha metropolitan engineering employment between 3,300 and 3,800.

Numerous additional conclusions are appropriate:

1. For reporting firms, expenditures for training and education will increase faster than employment. (Employment up 22.9% in five years with training budgets up 27.2%.)
2. Firms will increase internal training budgets (46%) relatively faster than external seminars (19%) and tuition reimbursement (18%), creating growing market opportunities for providers delivering educational services at the firm level.
3. Engineering positions will grow at about the same rate (25.3%) as that for all employees (22.9%).

4. Training budgets per engineering employee are more than double the amount for non-engineering employees now and in five years. This creates a very fast growth industry for professional engineering training at all levels.
5. Combined industry trends toward increased requirements for annual license renewal plus validation of professional continuing education programs may create training opportunities for universities.
6. The strongest demand for curriculum and programs included:
 - Civil –
 - Structural
 - Environmental, Sanitary, Geotechnical, General
 - Construction/Architectural
 - Electrical/Computer
 - Electrical/Power
 - Mechanical
7. The number of new engineering graduates from state university campuses will be less than the demand for such employees by metropolitan area firms for the foreseeable future.
8. A strong demand for educational services exists at both the undergraduate and graduate level.
9. Most metropolitan area firms hire only college graduates (baccalaureate) for professional engineering positions. Their growth in new positions is 260 to 300 annually.

Meanwhile, the University of Nebraska data suggest that only 50% of their graduates remain in Nebraska, and only 50% of those locate in the Omaha metropolitan area. Based on 369 1993 baccalaureate graduates from all campuses, the estimated annual metro supply of new baccalaureate graduates is approximately 90 graduates.

Once hired, most firms seek graduate opportunities for employees. The difference between the 9.5% of engineering employees now taking academic courses and the 21.5% employers think “should be taking academic courses” creates a substantial unmet local market for graduate and undergraduate services.
10. Information technologies have a substantial electronic engineering dimension to them - particularly as the computer, communications, audio/visual and other disciplines converge to create new platforms and business applications.

11. The integration of information technologies into structures, products, devices and processes is leading to an applied convergence of most information technologies and many engineering disciplines.
12. Local delivery of educational services is highly preferred to distance learning technologies. If distance learning technologies are employed, firms are inclined to seek the “best” providers available nationally.

Recommendations

1. Business has the opportunity to directly influence academic programs by:
 - creating partnerships between business and academia for joint appointments of highly qualified individuals to bring top quality talent to their firm and their university partner;
 - further defining specific needs in the Academic Disciplines and Applied Areas listed as most important in this study. This work should be done in close consultation with the academic community; and
 - working with universities and area high schools to develop creative programs that attract more students into all engineering programs. The objective is to close the gap between the growth in demand of engineering professionals and the number of new graduates.

2. Area universities may wish to:
 - develop high quality, locally available and comprehensive baccalaureate and graduate programs in:
 - Civil Engineering,
 - Electrical/Power,
 - Electrical/Computer,
 - Mechanical, and
 - Construction/Architectural.
 - create a vision for engineering that serves traditional markets while anticipating the convergence of information technology into the structures, devices, and processes of the future.
 - tightly align electronic engineering programs with information technology to support the continued integration of information technology into structures, machines, devices, and processes to create the logical marriage of multiple engineering disciplines.
 - aggressively seek the intellectual resources required by the integration and convergence of engineering disciplines and information technologies.
 - develop creative course structures and marketing programs that target students seeking master degrees who are employed by firms with tuition reimbursement programs.
 - establish techniques to partner with business for labs that are productive to both partners.

- develop techniques to allow greater mobility of academic resources and collegial partnerships across campus boundaries to match the convergence of technology and related applications in industry.
- develop incentives to encourage faculty training and re-training into applied engineering requirements of area/state businesses.
- develop a vision and plan to provide continuing educational services to area engineers and their employers.

Selected Bibliography

Engineering News Record, “Design Pay Struggles to Keep Up,” July 1995.

Greater Omaha Chamber of Commerce, “A Report of Engineering, Scientific and Technical Companies,” June 1991.

SRI International, “Engineering Education in Omaha: Views of Omaha Industrial Executives Regarding Company and Community Needs,” July 1994.

Nebraska State Board of Economics for Professional Engineers and Architects, “Fifty-seventh Annual Report for the Period July 1, 1994 to June 3, 1995.”

University of Nebraska, “Strategic Plan for Engineering and Technology Education in Nebraska: Report of the Task Force on Engineering Education,” 1994.

Appendices

Appendix A

Number of Practicing Engineers in the Omaha Metropolitan Area

1. Nebraska State Board of Examiners for Professional Engineers and Architects

In 1993, the Nebraska State Board of Examiners for Professional Engineers and Architects showed 4,378 professional engineers registered to practice in Nebraska. Those that had Nebraska mailing addresses totaled 1,942. The attached table summarizes registered engineers by address. Also shown are the number of professional engineers by engineering discipline.

Data for the five-county Omaha MSA are not available. Other metropolitan area mailing addresses include:

Omaha	Elkhorn
Ralston	Bellevue
Papillion	

Including the metropolitan area community, Omaha's engineering employment is 978. In addition, a scan of the Board's Directory shows numerous addresses from Washington County, Nebraska, plus Pottawatomie, Mills, and Harrison Counties in western Iowa, taking the total to over 1,030.

The 1994 directory shows a further increase to 4,589 engineers registered to practice in Nebraska. Assuming the same distribution of addresses as shown in the 1993 Directory, Omaha area employment would exceed 1,080.

The Board estimates that "non-professional engineers employed in industry outnumber professional engineers by 2.5 to 1."

These 1994 estimates suggest 3,780 registered and non-registered professional engineers in the metropolitan area.

2. Nebraska Occupational Information Systems

In 1991, the Nebraska Occupational Information System showed 6,274 people in engineering occupations. If the metropolitan area accounted for 53% of these employees, the metro employment would be 3,325.

**Registered Professional Engineers Residing in Nebraska*
by City within Nebraska
for the period July 1, 1992 to June 30, 1993**

City in Nebraska	Number	% of Total
Omaha	899	46.29
Lincoln	467	24.05
Columbus	112	5.77
Grand Island	37	1.91
Norfolk	27	1.39
Bellevue	26	1.34
Elkhorn	22	1.13
Hastings	22	1.13
Kearney	20	1.03
Papillion	18	0.93
York	17	0.88
North Platte	16	0.82
Auburn	13	0.67
Ralston	13	0.67
Fremont	10	0.51
McCook	10	0.51
Scottsbluff	10	0.51
All Others	203	10.45
State Total	1,942**	100.00

By Engineering Discipline

Engineering Discipline	Number	% of Total
Civil	846	43.56
Mechanical	382	19.67
Electrical	327	16.84
Structural	153	7.88
Agricultural	56	2.88
Chemical	21	1.08
Industrial	21	1.08
Control systems	8	0.41
Metallurgical	4	0.21
Nuclear	3	0.15
Manufacturing	2	0.10
Aeronautics	1	0.05
Fire Protection	1	0.05
Unknown	117	6.02
State Total	1,942**	100.00

**A total of 4,378 professional engineers were registered with the Nebraska State Board of Examiners for Professional Engineers and Architects. Of those, 1,942 shown above had Nebraska addresses*

***In addition, there are non-professional engineers employed in industry who outnumber professional engineers by approximately 2.5 to 1.*

Source: Nebraska State Board of Examiners for Professional Engineers and Architects, 55th Annual Report, June 30, 1993.

Appendix B

Demand for Engineers in the Omaha Metropolitan Area

Survey results show that projected engineering employment in five years will be 25.2% greater than today. This nearly 5% annual growth rate equates to 160-190 new engineers per year (assuming employment rates for non-respondents are the same as survey respondents and there are 3,300-3,800 engineers in the Omaha metropolitan area).

Allowing for another 3% of the engineering workforce to leave the field because of promotion, retirement or moving from the area, the total number of new engineers needed by Omaha metropolitan area employers is 260-300 annually.

A survey of UNL Engineering alumni (1985-1993) indicates that slightly over 50% of all engineering graduates reside in Nebraska. Half of those residing in Nebraska are employed in the Omaha area.²

Meanwhile, 1993 University of Nebraska engineering graduates with baccalaureate degrees totaled 287. Assuming those trends continue, the effective supply of UNL engineers to meet Omaha metropolitan area needs is about 70 graduates.

This represents a shortfall in the supply of new graduates to expected metropolitan area job growth of 190 to 220 engineers annually. If the requirements are added for new firms that choose to locate offices in the area, the shortfall is even greater. These data also do not reflect the increasing requirement for electrical/computer engineering skills by businesses that historically have not employed engineers.

These data also do not include the 82 engineer technology degrees offered by the University of Nebraska system. Inclusion of these graduates to the supply estimates still leave a substantial shortfall – particularly since many UNO graduates are already employed at the time of their graduation.

Graduate Programs

The above discussion focused on the demand for engineers at the baccalaureate level. Data from participating firms show that the number of engineers with post-graduate degrees is expected to increase from 340 to 655, or a 93% increase. These data translate to nearly 63 new graduate level positions per year. If 25% of UNL's 132 (1993) master and doctorate graduates took positions in Omaha, the total would equal 33. Thus, the demand from survey firms alone would double the expected number of available graduates

Using metropolitan area employment estimates of 3,300 to 3,800 engineers today, assuming a 5% annual growth in engineering employment plus the 93% increase in post-graduate engineers, this would translate to a requirement of nearly 565 to 650 more post-graduate engineers in five years. This annual demand of 110 to 130 would greatly exceed the expected number of new post-graduate engineers that will take employment in the metropolitan area.

² Strategic Plan for Engineering and Technology Education in Nebraska, November 1994, p. 14.

Appendix C

Demand for Engineers in the Omaha Metropolitan Area

Advanced American Technologies, Inc.	Kiewit Engineering Company
Alvine and Associates	Kirkham Michael and Associates
American Information Systems	Leo A. Daly Company
Applied Communications, Inc.	Lyman-Richey Corporation
Applied Power Associates, Inc.	McCallie Associates, Inc.
ARINC	Memcon Corporation
Batheja and Associates, Inc.	Metropolitan Utilities District
Belina science and Engineering, Inc.	Miller Electric
Boyd and Associates, Inc.	Northern Natural Gas Company
C. J. Schneider Energy	Omaha Airport Authority
California Energy Company, Inc.	Omaha Public Power District
Campbell Soup Company	Oriental Trading Company
City of Omaha, Plant Engineering Division	Porter Trustin Carlson Co.
Consolidated Business Systems, Inc.	Prochaska and Associates
Dultmeyer Engineering Services, Inc.	Professional Services Industries, Inc.
Facilities Resources, Inc.	Random Access/Entex
Farris Engineering, Inc.	R. G. Hay, Jr.
Geotechnical Services, Inc.	Rupprecht Engineering, Inc.
Grapevine Systems	Science Applications International Corp.
Great Plains Testing Labs, Inc.	Tecton/Divercon
HDR Engineering, Inc.	The Schemmer Associates, Inc.
Hiller Electric Company	Valmont Industries, Inc.
HunTel Communications, Inc.	Wells Engineers Environmental
HunTel Systems	Wells Engineers, Inc.
IBP, Inc.	Unidentified 90-Person Firm
ITT Defense Electronics	Unidentified 5-Person Firm
John Day Company	U.S. Army Corps of Engineers
Kiewit Construction Group	

Appendix D

Greater Omaha Engineering Curriculum Needs Survey Company Education/Training Profile 55 Firms

	Now	In Five Years	Percent Change
1. Number of All Employees (Greater Omaha)	16,125	19,815	22.88
2. Number of All Employees Now Taking Academic Credit Courses	1,255		
3. Number of All Employees You Feel Should Be Taking Academic Courses	3,178		
4. Number of Those Employees Taking Academic Credit Courses Who Are on a Company Tuition Reimbursement Program.	883		
5. Education/Training Budget - Nebraska Employers Amount of Training Budget for:	\$5,453,300	\$6,939,000	27.24
a. Internally Provided Training Programs	\$1,641,300	\$2,389,000	45.56
b. External Seminars & Workshops	\$2,804,800	\$3,344,000	19.22
c. Tuition & Cost for College Courses	\$956,200	\$1,129,000	18.07
d. Other	\$50,900	\$77,000	51.28

Greater Omaha Engineering Employees

6. Number of Engineering Employees	1,866	2,338	25.29
7. Number of Engineering Employees Now Taking Academic Credit Courses	178		
8. Number of Engineering Employees You Feel Should be Taking Academic Courses	402		
9. Number of Those Engineering Employees Taking Academic Credit Courses Who Are On a Company Tuition Reimbursement Program	169		
10. Education/Training Budget - Engineering Employees Only	\$1,969,000	\$2,783,700	41.38

**Profile of Academic Disciplines for Engineering Employees
Greater Omaha
55 Firms**

Academic Disciplines	Rank* Importance of Discipline to Your Firm	% Employees with These Disciplines	% Registered Engineers**	% Employees with These Disciplines in Five Years
Aerospace	3.79	0.05	0.00	0.17
Agricultural	3.93	0.16	33.33	0.25
Chemical	2.93	1.18	13.64	1.21
Civil - Structural	1.91	13.08	47.95	12.55
Civil - Environmental, Sanitary, Geotechnical, General	1.87	18.39	65.60	15.30
Construction/Architectural	1.98	12.28	33.62	13.05
Electrical/Power	1.81	12.06	19.11	13.47
Electrical/Computer	1.88	19.89	0.81	22.77
Environmental	2.20	3.59	61.19	3.34
Industrial/Manufacturing	3.01	2.09	23.08	2.29
Mechanical	1.82	12.55	32.48	11.88
Mining	4.00	0.54	0.00	0.54
Nuclear	3.32	1.45	7.41	1.00
Petroleum	3.97	0.00	0.00	0.00
Other		2.68	6.00	2.17
		% Baccalaureate	80.93	83.17
		% Graduate	18.45	27.98

Estimated Number of Employees by Academic Disciplines

Academic Disciplines	Rank* Importance of Discipline to Your Firm	# Employees with These Disciplines	# Registered Engineers**	# Employees with These Disciplines in Five Years	% Increase
Aerospace	3.79	1	0	4	300.00
Agricultural	3.93	3	1	6	100.00
Chemical	2.93	22	3	29	31.82
Civil - Structural	1.91	244	117	301	23.36
Civil - Environmental, Sanitary, Geotechnical, General	1.87	343	225	367	7.00
Construction/Architectural	1.98	229	77	313	36.68
Electrical/Power	1.81	225	43	323	43.56
Electrical/Computer	1.88	371	3	546	47.17
Environmental	2.20	67	41	80	19.40
Industrial/Manufacturing	3.01	39	9	55	41.03
Mechanical	1.82	234	76	285	21.79
Mining	4.00	10	0	13	30.00
Nuclear	3.32	27	2	24	-11.11
Petroleum	3.97	0	0	0	0.00
Other		50	3	52	4.00

*Rank 1=Most Important 4=Least Important

**Percent of present Engineering employees that are registered engineers.

**Greater Omaha Importance of Academic Discipline
55 Firms**

Academic Disciplines ● Applied Area	*Importance to Your Firm	**Need Met by Colleges & Universities	***Differences
Aerospace			
● Aero and Gas Dynamics	4.00	3.33	0.67
● Propulsion	4.00	3.33	0.67
● Aerospace Structures	4.00	3.33	0.67
● Flight Mechanics	4.00	3.33	0.67
● Spacecraft Systems	4.00	3.33	0.67
● Flight Control systems	4.00	3.33	0.67
● Aero Elasticity	4.00	3.33	0.67
● Other			
Agricultural			
● Biosystems Engineering	4.00	3.83	0.17
● Food engineering	4.00	3.83	0.17
● Power and Machinery	3.91	3.57	0.34
● Structures and Environment	3.66	2.97	0.69
● Process Engineering	3.75	2.99	0.76
● Water and Environment	3.62	2.98	0.64
● Waste Management	3.76	2.99	0.77
● Soil Management	3.85	2.85	1.00
● Other			
Chemical			
● Process Control	3.02	3.17	-0.15
● Process and Plant Design	3.09	3.17	-0.08
● Polymers and Polymer Engineering	3.77	2.73	1.04
● Petroleum Production and Refining	3.78	2.58	1.20
● Transport Operations	3.78	2.30	1.48
● Biochemical Engineering	3.90	2.65	1.25
● Other			
Civil			
● Structural	1.63	1.89	-0.26
● Construction	1.91	2.29	-0.38
● Geotechnical	2.02	1.91	0.11
● Geological	2.56	1.79	0.77
● Oceanography	3.90	2.92	0.98
● Transportation	2.41	2.42	-0.01
● Infrastructure/Utilities	1.66	2.19	-0.53
● Surveying	2.34	1.85	0.49
● Other			

*Rank 1=Most Important 4=Least Important

**Rank 1=Meets Needs 4=Does Not Meet Needs

***A positive value suggests needs are not being met. A negative value suggests needs are being met.

Academic Disciplines ● Applied Area	*Rank of Area	**Need Met by Colleges & Universities	***Differences
Construction/Architectural			
● Building Structures and Foundation	1.97	1374	0.23
● Heating, Ventilating and Air Conditioning	2.09	2.29	-0.20
● Plumbing/Drainage systems	2.30	2.29	0.01
● Fire Protection Systems	2.10	2.20	-0.10
● Lighting Design and Application	2.13	2.47	-0.34
● Building Acoustics	2.80	2.41	0.39
● Building Electrical Systems	2.09	2.18	-0.09
● Cost/Quality/Time Management	2.14	1.78	0.36
● Environmental Control Systems	2.25	2.31	-0.06
● Process Piping	2.27	2.43	-0.16
● Other			
Electrical/Power			
● Low Voltage Signal Communications Systems	2.28	2.28	0.00
● Control Systems	2.28	2.28	0.00
● Electric Power (emergency/standby/cogeneration/ prime power generation and distributing)	2.07	2.26	-0.19
● Electric Materials and Equipment	2.31	2.44	-0.13
● Other			
Electronic/Computer			
● Computer Systems/Architecture	2.13	2.44	-0.31
● Directories, Circuits, and Systems	2.78	2.42	0.36
● Communications, Control and Signal Processing	2.60	2.49	0.11
● LAN/WAN Networks, Architecture and Design	2.22	2.31	-0.09
● Wireless, Telephone, Fiber Optics	2.75	2.45	0.30
● CAD/CAM and Other Industry Design and Manufacturing Technology	2.15	2.04	0.11
● Electronic Devices/Circuit and Circuit Theory	2.76	2.26	0.50
● Bio-computing	3.82	2.78	1.04
● Other			
Environmental			
● Emissions/Effluent Control	2.26	2.41	-0.15
● Solid Waste Handling/Recycling	2.14	2.47	-0.33
● Water/Waste Water Treatment	1.89	2.28	-0.39
● Hazardous/Toxic/Radioactive Waste Management/Cleanup	2.31	2.68	-0.37
● Impact Assessment Studies/Statements	2.38	2.73	-0.35
● Underground Storage Facilities/Tanks	2.49	2.81	-0.32
● Water Management/Flood Control	2.70	2.31	0.39
● Other			

*Rank 1=Most Important 4=Least Important

**Rank 1=Meets Needs 4=Does Not Meet Needs

***A positive value suggests needs are not being met. A negative value suggests needs are being met.

Academic Disciplines ● Applied Area	*Rank of Area	**Need Met by Colleges & Universities	***Differences
Industrial/Manufacturing			
● Process Flow Design	3.27	2.12	1.15
● Manufacturing Automation and Assembly	3.64	2.04	1.60
● Human-Machine Interface	3.32	2.04	1.28
● Electronic Packaging	3.93	1.68	2.25
● Integrated Circuit Manufacturing	3.88	1.72	2.16
● Other			
Mechanical			
● Manufacturing Processes	3.32	2.65	0.67
● Operation & Environmental Consideration in Design	2.69	2.41	0.28
● Industrial Ventilation Systems	2.55	2.43	0.12
● Fluid Power and Control	2.28	2.37	-0.09
● Machine and Systems	2.70	2.20	0.50
● Power Generation	1.91	2.35	-0.44
● Engineering Measurements and Instrumentation	2.40	2.14	0.26
● Heat Transfer/Energy Systems	2.04	2.26	-0.22
● Materials Science/Metallurgy	2.80	2.15	0.65
● Hydraulics	2.53	2.13	0.40
● Bio-Technical/Robotics	3.63	2.71	0.92
● Other			
Mining			
● Rock Mechanics	3.79	2.80	0.99
● Rock Fragmentation	3.79	2.80	0.99
● Mine Health, Safety and Regulation	3.77	2.80	0.97
● Solution Mining	3.99	3.94	0.05
● Geostatistics	4.00	3.94	0.06
● Mineral Economics	4.00	2.45	1.14
● Hazardous Waste Control and Reclamation	4.00	3.37	0.63
● Other			
Nuclear			
● Transport Theory and Computational analysis	3.43	3.98	-0.55
● Reactor Dynamics and Safety	3.43	3.98	-0.55
● Materials for Reactors and Radiation Effects	3.43	3.98	-0.55
● Reactor thermal-Hydraulics	3.43	3.98	-0.55
● Health Physics	3.40	3.98	-0.58
● Waste (high and low level)	3.13	3.69	-0.56
● Other	4.00	3.52	0.48
Petroleum			
● Drilling, Production and Operations	3.99	3.94	0.05
● Petrophysics	3.99	3.94	0.05
● Recovery	3.99	3.94	0.05
● Transportation	3.99	3.94	0.05
● Other			

*Rank 1=Most Important 4=Least Important

**Rank 1=Meets Needs 4=Does Not Meet Needs

***A positive value suggests needs are not being met. A negative value suggests needs are being met.

**Engineering Business Issues
55 Firms**

Business Issues	Rank* Importance to Your Company	
	Currently	In Five Years
Life Cycle Cost Analysis	1.85	1.59
Client/Engineering Management	1.77	1.29
Professional Ethics	1.09	1.09
Business Development/Marketing	1.62	1.24
Quality/Assurance Management Programs	1.70	1.55
Employee Recruitment and Retention	1.38	1.37
Preparation/Maintenance re: Professional Registration	1.97	1.68
Contractual Law and Responsibilities	1.96	1.68
Specification/Technical Report Writing	1.79	1.59
Industry Computer Software	2.06	1.84
Industry Codes and Standards (ISO, ASTM, UL, ANSI, UBC/BOCA, Federal, Military, etc.)	1.85	1.82
Regulatory Impacts (OSHA, EPA, ADA, etc.)	1.70	1.65
Safety	1.57	1.46
Hazardous Waste Management/Regulation	2.06	1.86
Technology Transfer	1.99	1.83
Other		

**Rank 1=Most Important 4=Least Important*