University of Alaska

UA Engineering Plan 2010

DRAFT REPORT

January 24, 2011 (Draft E1)

IRA FINK AND ASSOCIATES, INC.
UNIVERSITY PLANNING CONSULTANTS

University of Alaska

UA Engineering Plan 2010

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Prepared for:

Ms. Kit Duke
Chief Facilities Officer
University of Alaska
910 Yukon Drive
Butrovich Building, Room 106D
Fairbanks, Alaska 99775
(907) 474-5299

Prepared by:

Ira Fink and Associates, Inc.
University Planning Consultants
One Columbia Circle
Berkeley, California 94708
(510) 843-1900

Ira Fink and Associates, Inc.

UAA, Engineering Building, Room 105, Geomatics Laboratory. This laboratory is also known as the Trimble Laboratory due to its strong support in the form of funding and in-kind contributions of specialized software and surveying equipment.

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List of Persons who were Interviewed and/or Attended Meetings

Steering Committee

Duke, Kit, Chief Facilities Officer, University of Alaska, Statewide Finance and Planning
Goering, Douglas, Dean, College of Engineering and Mines, University of Alaska Fairbanks
Lang, Rob, Dean, School of Engineering, University of Alaska Anchorage
Pitney, Pat, Vice Chancellor, Administrative Services, University of Alaska Fairbanks
Spindle, Bill, Vice Chancellor, Administrative Services University of Alaska Anchorage
Turletes, Chris, Associate Vice Chancellor, Facilities and Campus Services, University of Alaska Anchorage
Zanazzo, Linda, Director, Facilities Services, University of Alaska Fairbanks

UAA School of Engineering Advisory Board (SOEAB)

Armstrong, Richard
Aho, John, Consultant
Brooks, Anne
Brooks, Paul
Call, Catherine
Christianson, Derek
Follett, Tony
Gropp, Dora
Hills, Alex
Lau, John
Leman, Loren
Opheen, Trish
Reich, Richard
Weaver, Steve
Zufelt, Jon

Consulted and/or Interviewed

Abaza, Osama, Professor, Highway and Transportation Engineering, Department of Civil Engineering, University of Alaska Anchorage
Baker, Grant, Associate Dean, School of Engineering, University of Alaska Anchorage
Bandopadhyay, Sukumar, Professor, Department of Mining and Geological Engineering, University of Alaska Fairbanks
Barnes, David, Professor and Chair, Department of Civil and Environmental Engineering, University of Alaska Fairbanks
Bean, John, Department of Geomatics, University of Alaska Anchorage
Brock, Jennifer, Assistant Professor, Department of Mechanical Engineering, University of Alaska Anchorage
Driscoll, Michael, Provost and Vice Chancellor for Academic Affairs, University of Alaska Anchorage

List of Persons who were Interviewed and/or Attended Meetings

Dong, Yuan-Fang, Senior Research Associate, Institutional Research, University of Alaska Anchorage

Faunce, John, Director, Facilities Planning and Construction, University of Alaska Anchorage

Ganguli, Rajive, Professor and Chair, Department of Mining and Gelogical Engineering, University of Alaska Fairbanks

Gienko, Gennady, Associate Professor, Department of Geomatics, University of Alaska Anchorage

Hanks, Cathy, Associate Professor and Chair, Department of Petroleum Engineering, University of Alaska Fairbanks

Hazelton, Bill, Associate Professor, Department of Geomatics, University of Alaska Anchorage

Henrichs, Susan, Provost and Executive Vice Chancellor for Academic Affairs, University of Alaska Fairbanks

Holdmann, Director, Alaska Center for Energy and Power, University of Alaska Fairbanks

Hollis, Tanya, Director, Statewide Office of Cost Analysis, University of Alaska

Horner, Deborah, University Planner, Office of the Provost, University of Alaska Fairbanks

Ilgenfritz, Linda, Administrative Manager, College of Engineering and Mines, University of Alaska Fairbanks

Julius, Daniel, Vice President for Academic Affairs, University of Alaska System

Kolean, Geeta, Fiscal Manager, School of Engineering, University of Alaska Anchorage

Lew, Mark, Policy Analyst, Statewide Institutional Research and Planning, University of Alaska

Lobontiu, Nicolae, Associate Professor, Department of Mechanical Engineering, University of Alaska Anchorage

Lund, Assistant Professor, Department of Mechanical Engineering, University of Alaska Anchorage

Murphy, Kathleen, Facilities Scheduling Coordinator, Publications and Scheduling, University of Alaska Anchorage

Nelson, Tim, CAD/GIS Operations Manager, Facilities Planning and Construction, University of Alaska Anchorage

Olson, Ian, Director, Planning, Analysis and Institutional Research, University of Alaska Fairbanks

Pugh, John, Chancellor, University of Alaska Southeast

Quimby, T. Bartlett, Associate Vice Provost for Curriculum and Assessment, Office of Academic Affairs and Professor, Department of Civil Engineering, University of Alaska Anchorage

Ravens, Thomas, Professor and Chair, Department of Civil Engineering, University of Alaska Anchorage

Rogers, Brian, Chancellor, University of Alaska Fairbanks

Schnabel, Bill, Director and Associate Professor, Water and Environmental Research Center, University of Alaska Fairbanks

Schweitzer, Saltanat, Manager, Planning and Institutional Research, University of Alaska

Ulmer, Fran, Chancellor, University of Alaska Anchorage

White, Daniel, Director, Institute of Northern Engineering, University of Alaska Fairbanks

White, Gwen, Associate Vice President, Planning and Institutional Research, University of Alaska

Wohlford, Marc, Senior Project Manager, Division of Design and Construction, University of Alaska Fairbanks

List of Persons who were Interviewed and/or Attended Meetings

Employer Interviews

Aho, John, Consultant, CH2M HILL/Retired, Anchorage

Bergman, Todd, Executive Director, Alaska Processing Industry Careers Consortium (APICC), Fairbanks

Bergstedt, Mack, President, RSA Engineering, Inc., Anchorage

Borell, Steve, Executive Director, Alaska Miners Association, Fairbanks

Brokaw, Thomas, Human Resources Superintendent, Sumitomo Metal Mining Pogo LLC, Fairbanks

Follett, Tony, Chief Operating Officer, Anchorage Regional Office, Aero-Metric, Inc., Anchorage

Gropp, Dora, Director, Transmission and Substation Engineering, Chugach Electric Association, Inc., Anchorage

Knight, Sherilyn, Human Resource Manager, Department of Transportation and Public Facilities, State of Alaska, Fairbanks

Opheen, Trish, Chief of Engineering Division, Alaska District, Army Corps of Engineers, Anchorage

Pospisil, Gordon, Manager, Technology, Seismic Delivery & Organizational Capability, BP Exploration (Alaska), Inc., Fairbanks

Rosenbluth, Burt, Project Management Supervisor, ConocoPhillips Alaska, Inc., Fairbanks

Wilbur, Jack, President, Design Alaska, Fairbanks

Witt, Kay, Operations Manager, AT&T Alascom, Anchorage

Other

Corazza, Peggy, Data Manager, Assessment and Accountability, Alaska Department of Education and Early Development

Gaborik, Karen, Principal, Lathrop High School, Fairbanks, Alaska

Holland, Amanda, Department of Transportation and Public Facilities, State of Alaska

Jones, Richard, Executive Administrator, Architects, Engineers and Land Surveyors Board

Latreille, Gregory, PE, President, Alaska Society of Professional Engineers

Meissner, Brian, Architect, ECI/Hyer

Rasmussen, Dean, Economist, Occupational Information Unit Supervisor, Alaska Department of Labor and Workforce Development, Research and Analysis Section

Roach, Wade, Science, Math, and Technology, Dimond High, Anchorage School District

Schroeder, Herb, Vice Provost for ANSEP, University of Alaska Anchorage

Consultants

Ira Fink, Ph.D., FAIA
Ira Fink and Associates, Inc., University Planning Consultants
Berkeley, California

Annie Noah
Ira Fink and Associates, Inc.

Stacy Teitel
Ira Fink and Associates, Inc.

Terry Brown
Research Facilities Design, Laboratory Design Consultants
San Diego, California

F

Foreword

Ira Fink and Associates, Inc.

UAF, Duckering Building, Room 444. The Quinton Costello Laboratory is an Environmental Analytical Lab which houses the Alaska Stable Isotope Facility and part of the Water and Environmental Research Center in INE (Institute of Northern Engineering). In the foreground are a gas chromatograph and mass spectrometer system. The small test tubes hold water samples that will be analyzed to identify the organic material in the sample. The Costello lab was named for a University of Alaska Fairbanks researcher, Quinton Daniel Costello, who was killed in a helicopter crash while studying climate change on the North Slope of Alaska.

FOREWORD

Background

This study describes the recent success the University of Alaska has had in increasing the number of students with engineering degrees to help meet the demand for engineers in Alaska. This gain in graduates has been preceded by large increases in engineering enrollment, which in turn has taxed the engineering facilities at the University of Alaska Anchorage and the University of Alaska Fairbanks.

Engineers Employed in Alaska

To gain an understanding of the circumstances underlying the recent surges in engineering student enrollments at the University of Alaska and the employment demand for engineering graduates in the State, IFA consulted the recent National Science Foundation publication *Science and Engineering Indicators 2010*. This omnibus study of science and engineering across the U.S. provides a glimpse into the underlying factors of engineering supply and demand across the U.S. as a whole and individually in all states, as well.

For example, according to the *Science and Engineering Indicators 2010* report, in 2008 there were 4,450 engineers employed in Alaska out of a total labor force of 357,136. In other words, engineers comprised 1.25 percent of the State of Alaska workforce. As shown below in Table F-1, in 2008, only nine states had a higher percentage of engineers in their labor force. In contrast to Alaska, with its natural resources based economy, those states with higher rates of engineers in the workforce included California, Colorado, Connecticut, Maryland, Massachusetts, Michigan, Texas, Virginia, and Washington, all known for their technology-laden economies. Both natural resources development and technology development rely heavily on engineers.

Table F-1

Engineers as Share of Work Force, 2008

State	Engineers	Employed Workforce	Engineers in Workforce (%)
Michigan	92,190	4,935,584	1.87
Washington	55,490	3,476,766	1.60
Massachusetts	54,330	3,424,018	1.59
Colorado	41,430	2,730,447	1.51
Virginia	54,280	4,124,766	1.32
California	240,860	18,391,844	1.31
Maryland	39,390	2,997,709	1.31
Connecticut	23,920	1,876,125	1.27
Texas	146,520	11,701,585	1.25
Alaska	**4,450**	**357,136**	**1.25**
Total United States	**1,626,330**	**153,999,337**	**1.06**

Source: National Science Board, 2010. *Science and Engineering Indicators 2010.* Arlington, Virginia: National Science Foundation (NSB 10-01), Table 8-30.

However, this 2008 picture for Alaska was not always as bright. In the year 2004, there were 16 states that had a higher percentage of engineers in the workforce than did Alaska. By the year 2006, this gap had become even larger as there were 22 states with a larger percentage of engineers in the workforce.

What occurred in the period between 2004 and 2008 is that the percentage of engineers in the State of Alaska workforce declined from 1.10 percent of the Alaska workforce being engineers in 2004, to a low of 1.03 percent in 2006, and then jumped to 1.25 percent in 2008. In other words, the demand for a trained engineer labor force increased dramatically in Alaska in a very short period of time, creating a labor demand that could not be immediately met.

Engineering Education in Alaska

The backdrop for education in Alaska, as a precursor to employment, is also presented in the *Science and Engineering Indicators 2010* report. The report shows that in 1997, Nevada was the only other state in the nation that had a lower percentage of students with degrees in the natural sciences and engineering conferred per 1,000 individuals who were 18 to 24 years old (college age) than did Alaska. In 1997, only 4.5 percent of the degrees conferred to every 1,000 individuals in the 18 to 24 year old age bracket in Alaska were engineering degrees. By the year 2002, this percentage had dropped to 3.6 percent and again, only Nevada had a lower percentage.

In 2007, Alaska stood alone as the state with the lowest percentage of bachelor's degrees in the natural sciences and engineering conferred per 1,000 individuals in the 18 to 24 year old age bracket. In 2007, it stood at 3.7 percent in Alaska.

Thus, the demand for a highly educated labor force, as shown in the first part of this Foreword, was hampered by the lower availability of a highly educated labor force in Alaska, as evidenced by the data about degrees conferred. By comparison, for the entire United States, in 1997, 8.6 percent of the degrees conferred to every 1,000 individuals ages 18 to 24 was in science and engineering; by 2002, this had declined across the U.S. to 8.1 percent; by 2007, it again had increased to 8.6 percent, or more than twice the average of Alaska.

Science and Engineering Degrees in Alaska

What also was happening at the same time was that the percentage of natural sciences and engineering degrees, as a share of all higher education degrees conferred in Alaska, declined during the period from 1997 to 2007. According to *Science and Engineering Indicators 2010*, in 1997, students who earned a natural sciences or engineering degree that was conferred in Alaska totaled 21.9 percent of all conferred degrees. In 1997, only six states in the United States had a higher percentage of science and engineering graduates,[1] as shown in Table F-2.

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1 Science and engineering includes the physical, earth, ocean, atmosphere, biological, agricultural, computer and social sciences, mathematics, engineering, and psychology.

Table F-2

Natural Sciences and Engineering Degrees as a Share of Higher Education Degrees Conferred, 1997

State	NS&E/Higher Education Degrees (%)	Total NS&E Degrees	All Higher Education Degrees
Wyoming	38.5	818	2,124
Montana	26.4	1,504	5,706
South Dakota	24.2	1,336	5,512
Colorado	23.4	6,625	28,304
California	23.3	35,241	151,485
Idaho	22.9	1,298	5,656
Alaska	**21.9**	**440**	**2,009**
Total United States	**18.4**	**300,380**	**1,636,726**

Source: *Science and Engineering Indicators 2010*, Table 8-18.

Table F-3

Natural Sciences and Engineering Degrees as a Share of Higher Education Degrees Conferred, 2007

State	NS&E/Higher Education Degrees (%)	Total NS&E Degrees	All Higher Education Degrees
Wyoming	34.7	748	2,154
Montana	24.1	1,571	6,509
Maryland	23.6	9,891	41,936
New Mexico	22.6	2,201	9,748
South Dakota	22.0	1,405	6,386
California	21.0	42,934	204,838
Colorado	20.9	7,506	35,981
Georgia	20.7	10,230	49,495
Alabama	20.3	6,550	32,207
Wisconsin	20.2	8,433	41,842
North Carolina	19.9	10,947	55,071
Virginia	19.9	10,747	53,981
Michigan	19.6	14,726	75,304
Utah	19.6	4,707	23,993
Washington	19.6	7,364	37,541
Alaska	**19.4**	**438**	**2,261**
Total United States	**17.6**	**375,931**	**2,138,003**

Source: *Science and Engineering Indicators 2010*, Table 8-18.

By 2002, five years later, this excellent situation changed, as students with science and engineering degrees in Alaska had taken a measurable drop. Twenty-four states ranked higher than Alaska in the percentage of their graduates who received natural sciences and engineering degrees. In 2002, 18.5 percent of degrees in Alaska were in the natural sciences and engineering. By the year 2007, the situation had begun to correct itself, but had not yet reached the highwater mark that occurred in 1997. In the year 2007, there were 15 states that had a higher percentage of natural sciences and engineering degrees granted or conferred in 2007 than did Alaska, as shown in Table F-3. In that year, 19.4 percent of all degrees granted in Alaska were in natural sciences and engineering, but this was still below the high point reached in 1997.

Graduate Degrees in Science and Engineering in Alaska

At the graduate degree level, Alaska fares much better. In 1997, 2002, and 2007, only six states awarded a higher percentage of science and engineering degrees at the advanced level (master's and doctorate) than did Alaska. This is shown in Table F-4. In 2007, nearly one-third of the S&E degrees awarded in Alaska were graduate degrees.

As shown in Table F-4, Alaska's numbers are small in comparison to the other states, yet, proportionately Alaska fares quite well.

Table F-4

Advanced S&E Degrees as a Percent of All S&E Degrees

State	Advanced S&E Degrees			All S&E Degrees			Advanced S&E/ All S&E Degrees (%)		
	1997	2002	2007	1997	2002	2007	1997	2002	2007
District of Columbia	3,036	3,030	3,558	6,566	7,074	7,889	46.2%	42.8%	45.1%
Illinois	6,466	6,786	9,205	21,877	23,368	27,328	29.6	29.0	33.7
Maryland	3,483	3,927	4,886	11,867	13,135	15,800	29.4	29.9	30.9
Massachusetts	6,496	6,760	7,906	21,879	23,196	25,519	29.7	29.1	31.0
New Mexico	868	708	854	2,764	2,438	2,863	31.4	29.0	29.8
Alaska	**199**	**156**	**235**	**679**	**559**	**725**	**29.3**	**27.9**	**32.4**
Total United States	**119,428**	**122,569**	**150,127**	**503,939**	**533,788**	**626,200**	**23.7%**	**23.0%**	**24.0%**

Source: *Science and Engineering Indicators 2010*, Table 8-20.

Need for Additional Engineering Education

Measuring the adequacy of an engineering labor force and the educational requirements is a complicated task. It involves making education assumptions regarding the educational histories and careers of engineers at all degree levels. It requires data about engineering employment and engineering careers. Fortunately, the Alaska Department of Labor and Workforce Development tracks this information and develops forecasts and projections every two years; these are the basis for estimating the engineering workforce needs in Alaska used in this study.

Likewise, identifying the demand for and need of additional engineering education in Alaska is an extremely important activity. This includes not only assumptions and estimates of the number of students interested in an engineering education, but also an analysis of whether or not there is a market for their talents upon graduation. Clearly, there is, as this report illustrates.

As this study illustrates, students in Alaska are interested in an engineering education. Many enter their engineering degree programs immediately upon graduation from an Alaska high school. Others want to enter the program, but require additional coursework to qualify, and then do so. And, others come into the engineering programs at the University of Alaska after first leaving the State following their high school graduation to study elsewhere, then return to Alaska as transfer students to complete their degrees.

While many students are entering the University's engineering programs, not all succeed. Today, the graduation rates are such that the University of Alaska is expanding its efforts to meet its goal of educating more engineers for the State.

1

Introduction

Engineering Expansion Initiative

Steering Committee

Study Process

Organization of this Report

Ira Fink and Associates, Inc.

UAF, Duckering Building, Room 302. The Mine Ventilation Laboratory has the most advanced instruments for the measurements of atmospheric environmental conditions (gas, dust, heat and humidity velocity and pressure of air) in mines. The unique feature of the laboratory is a mine model (as two mine airways in parallel). Two fans are of centrifugal type and blow air into the airways. The fans can be operated in parallel. A "CONSPEC Senturion 500 Mine Ventilation monitoring and control system" which is an integral part of the ventilation laboratory has been installed for remote and continuous monitoring of mine environment.

I. INTRODUCTION

This section describes the University of Alaska Board of Regents Engineering Expansion Initiative, outlines the structure of the committees assisting in the development of this report, and outlines the study process.

A. ENGINEERING EXPANSION INITIATIVE

Background and Primary Goal of the Engineering Expansion Initiative

In November 2007, the University of Alaska Board of Regents adopted the Engineering Expansion Initiative as part of the approval of the fiscal year 2009 University of Alaska operating and capital budget request to the State of Alaska. The primary goal of the Regents Engineering Expansion Initiative is stated as follows:

> "By 2012, UAA and UAF will produce 200 undergraduate trained engineers annually, more than doubling the annual number of current undergraduate trained engineers."

At the time of the adoption of the Initiative, the UAA and UAF programs combined were graduating 70 to 80 students per year with engineering degrees.

Other Goals of the Initiative

The Initiative also contained a number of other goals, which are also reviewed in this study, including the following:

- By 2012, produce 20 baccalaureate Construction Management graduates and train 40 to 60 certificate and two-year Construction Technology program graduates annually.
- By 2012, including the 200 undergraduate trained engineers, produce a total of 340 graduates in engineering-related programs from certificate and associate to Ph.D. level programs. This includes surveying and mapping, Master's programs, and post-baccalaureate certificates in areas such as Arctic Engineering.
- Increase the number of Project Management certificate and Master's degree recipients.
- Increase the number of students graduating from Alaska high schools who desire a career in engineering. These students will have the necessary math and science skills to be successful in engineering. A special emphasis will be placed on attracting UA Scholars and first-generation college students.
- Expand engineering research capacity in areas important to Alaska, including transportation, energy, and climate adaptation. Over the next four years, increase engineering-related research by 50 percent from $18 million to $27 million.
- Expand professional development opportunities for existing professionals as continuing education will be required for maintenance of the Professional Engineer (PE) license.

- Develop 1+3 programs at Juneau, Mat-Su, Kenai, and other UA community campuses as first-year feeder programs into the UAA and UAF engineering programs.
- Increase the number of scholarships available to engineering students reaching senior status in time to graduate within 5 years. Promote on-time graduation and full-time enrollment to completion.
- Develop centers of excellence in niche disciplines such as energy, arctic engineering, and transportation through establishing ten named professor positions.

Measures of Success

The Engineering Expansion Initiative also included a series of measures of success. The indicators that were to be followed to predict and measure success of the Initiative include:

- Increase enrollment and retention rates of students with declared engineering majors.
- Increase graduation rates in the engineering disciplines.
- Create joint college and School of Engineering alliances that include regular gatherings of the representatives to collaborate towards attaining aligned goals.
- Conduct regular joint meetings among colleges and School of Engineering advisory councils, and dean/faculty/staff groups.
- Establish joint strategies to be implemented and supported by UA engineering programs.
- Increase the number of internship and scholarship opportunities.
- Maintain the excellent in-state job placement rates for UA engineering graduates.

B. STEERING COMMITTEE

Statement of Purpose

To guide the development of the UA Engineering Plan 2010, the campus Chancellors and the University's Chief Facilities Officer, Kit Duke, agreed to:

- Form a Steering Committee of campus engineering deans and facilities officers and other appropriate staff to work with UA Chief Facilities Officer to guide and inform the process of designing and implementing the University of Alaska Engineering Plan 2010.
- Include the existing joint Engineering Advisory Committee, consisting of four members from each campus' Advisory Committee, to work with the UA Chief Facilities Officer and Steering Committee to inform the process of plan development.
- Support the development of new facilities and renovation required to meet the needs of current engineering enrollees at both campuses. The current enrollments, which have grown substantially in recent years, are to be used to define the minimum level of needs for facilities at each campus.

- Develop a comprehensive view of engineering programs at a statewide level to help project and document any additional needs for space in future years.

The Steering Committee in June 2010 agreed to the following statements of purpose for the development of the Engineering Plan 2010:

- Achieve alignment between UA, UAA, and UAF on the key issues associated with delivering of engineering degrees and improving effectiveness in communicating about the future of capital requests for construction.
- Consider whether to update or modify the Board of Regents Engineering Expansion Initiative for current conditions in context and time frame targets.
- Frame current space needs at each campus and establish the construction requirements to meet the goals of accommodating education and associated research for the University of Alaska engineering program.
- Provide, as part of program due diligence, assurance that the University's recruitment, admission, and retention process results in timely degree completion for the engineering degree programs.
- Document the projected academic year in which 200 graduates per year will be reached, including identifying growth potential for the following five to ten years and identify issues, benefits, and impacts associated with growth.
- Provide assurance that an institutional approach to meeting current student and employment demand is applied prior to designing a building for each campus.
- Set forth requirements for maintaining existing associated research and graduate program capacity, and address and document potential for future growth of these programs.

The Engineering Plan 2010 will also:

- Document the State's need for engineers, including anticipated placement for the numerous disciplines;
- Project the need into the future to establish a baseline of engineers needed in Alaska; and,
- Confirm the goal for annual graduates.

Space Needs

The Steering Committee has stated that the plan is to include a review of the campus' self-analysis for current space for engineering programs. The plan study is also to determine, when compared to program peers, if each campus has had a space deficit or surplus, both in quantity and type of space.

Based on the information provided in the plan, the Steering Committee will develop a joint program statement in which academic and support space needs will be articulated. This will allow each campus to develop the required project agreements and proceed with their project design process. This plan will also spell out how the increase in space at each campus will be used to accomplish academic priorities and goals for engineering that are in compliance and alignment with the draft UA Academic Master Plan. The plan will also document and support how space vacated due to any new construction will be used.

In short, the Engineering Plan 2010 will be a coordinated evaluation of delivery for engineering programs, focused on the review of existing and projection of future needs for academic space.

C. STUDY PROCESS

The study process for this Engineering Plan 2010 has involved numerous activities to further define the need for space for the engineering programs at UAA and UAF.

The study process included:

- Initial meetings at UAA, UAF, and Statewide to meet with the campus leadership, engineering deans, and faculty and support staff on both campuses.
- Extensive review of historical enrollment data by program type and academic level, prepared by the Statewide Office of Institutional Research and Planning.
- Development of a simulation model to predict in what time frame 200 engineering trained undergraduates would complete their degree work.
- Summarizing and codifying the existing in-house space inventories for campus-owned space, as well as off-campus space used for programs at both UAA and UAF.
- Detailed review of existing space, both on- and off-campus, by type, distribution, and amount.
- Development of complete faculty and staff rosters based on faculty information on the UAA and UAF websites, as well as special data runs prepared for the study by the UA Statewide Office of Planning and Institutional Research.
- Tabulation of faculty positions and development of a space predictive tool using space per faculty as the criteria.
- Phone interviews with a selected number of employers of UA graduates to determine the extent to which UA graduates are hired and if not, where the selected firms search for new employees.
- A review of STEM (Science, Technology, Engineering, and Math) programs in place throughout Alaska.
- Identification and analysis of existing engineering academies at two high schools in Alaska, and the start up connected with integrated engineering curriculum developed by the firm Project Lead the Way.
- A walkthrough of all facility space assigned to UAA and UAF by IFA and RFD (a sub-consulting firm devoted to laboratory programming, planning, and design).
- A review of the facility programs by IFA and RFD for the proposed new buildings at UAA and UAF.

D. ORGANIZATION OF THIS REPORT

This report is organized as a series of topical sections, each relating to a distinct aspect of the overall study. The individual sections are as follows:

Foreword

To gain an understanding of the circumstances underlying the recent surges in engineering student enrollment at the University of Alaska and the employment demand for engineering graduates in the State, the Foreword provides a series of indicators of the factors underlying engineering supply and demand across the U.S. as a whole, and individually in states, as well.

Recommendations

While there has been success and accomplishment in meeting the objectives of the Regents' Engineering Expansion Initiative, a number of challenges still exist. The recommendations, if accepted and adopted, would form the basis for a plan for engineering at the University of Alaska for the following decade.

Executive Summary

The Executive Summary describes the Engineering Plan 2010. It also provides a summary progress report card on how well each of the objectives of the Board of Regents' 2007 Engineering Expansion Initiative has been met. Lastly, a summary of the major findings of the study is provided.

1. Introduction

This section describes the University of Alaska Board of Regents Engineering Expansion Initiative, outlines the structure of the committees assisting in the development of this report, and outlines the study process.

2. Engineering Enrollments at the University of Alaska

Both the University of Alaska Anchorage (UAA) School of Engineering and the University of Alaska Fairbanks (UAF) College of Engineering and Mines offer a wide range of engineering programs and degrees. This section describes the substantial growth in the current and immediate past historical enrollments in these programs at both campuses. The enrollment data was provided by the University of Alaska Statewide Planning and Institutional Research Office.

Although this study is being conducted at the start of the fall 2010 academic year, for consistency purposes and completeness of data, it has been agreed that the end year for data analysis purposes would be fall 2009.

3. Projected Engineering Enrollments and Projected Graduates at the University of Alaska

This section expands upon the enrollment data presented in Section II by reviewing graduation rates, projecting future enrollments, and projecting the year in which a combined total of 200 Bachelor of Science graduates per year would be reached at UAA and UAF.

4. Engineering-Related Enrollments and Graduates at the University of Alaska

This section describes the engineering-related programs, enrollments, and graduates at the University of Alaska Anchorage and the University of Alaska Fairbanks, including UA Community and Technical Colleges.

5. Engineering Faculty and Staff at the University of Alaska

This section describes engineering faculty and staff employment at the University of Alaska Anchorage and the University of Alaska Fairbanks. The engineering faculty and staff employment data were provided by the University of Alaska Statewide Planning and Institutional Research Division, based on employee records as of August 24, 2010.

The purpose of this section is both to provide an up-to-date record of faculty and staff employment, and to provide baseline data for projecting space needs. Separate analyses are provided for UAA and UAF.

6. Engineering Employment in the State of Alaska

This section describes engineering employment in the State of Alaska, as measured by the State Department of Labor and Workforce Development (DOLWD). The DOLWD projections of engineering employment for the State of Alaska for the period 2008 to 2018 are also described. This section includes a description of the licensing of engineers in Alaska.

7. Engineering Program Space at the University of Alaska

This section documents the facilities and the existing square footage of these facilities assigned to the School of Engineering at the University of Alaska Anchorage and the College of Engineering and Mines at the University of Alaska Fairbanks.

8. Engineering Space Needs Projections

This section describes the methodology for and projections of space needs at the University of Alaska Anchorage and the University of Alaska Fairbanks. The purpose is to provide a general framework for quantifying and projecting engineering space needs as an order of magnitude quantity. It does not provide programmatic detail on individual room-by-room space requirements.

9. Proposed Engineering Buildings

This section describes current proposals developed by the University of Alaska Anchorage and the University of Alaska Fairbanks to construct new facilities to meet the space needs of the engineering programs on both campuses. This section describes the studies prepared for the two campuses and provides observations about the project proposals by RFD and IFA.

10. Engineering Graduates

This section has two purposes. First, to describe and quantify the number of graduates of the various engineering programs at the University of Alaska during the time period 2000 to 2010 and to indicate how these engineering graduates are employed in the year 2010. The second purpose is to provide a brief narrative about engineering employment in the State of Alaska based on employer interviews conducted as part of this study.

11. Continuing Education of Engineers in Alaska

This section describes the requirement for continuing education for licensed engineers in the State of Alaska. It also describes how continuing education credits are achieved.

12. Opportunities for Growth; Impediments to Growth

This section describes components of the engineering enrollment "pipeline" for the University of Alaska prior to enrollment. This includes changes in the number of high school graduates in the State of Alaska and efforts to prepare students for entering the engineering programs through participation in engineering academies at high schools in Alaska, and engineering course work curriculum of Project Lead the Way. In addition, activities to improve high school science, technology, engineering, and math (STEM) programs are also described.

13. Findings

During the course of this study, a considerable amount of time was spent locating data about the engineering programs enrollments, graduates, employment for graduates, space, and space needs. This section describes the major findings of the *Engineering Plan 2010* study.

14. Entering Engineering and Completing a Degree

This section provides data on various methods used to calculate the time students take to complete their degrees. It also contains data and analysis on the various portals used to enter engineering programs, including first-time freshmen, returning students, and transfer students, both internal University of Alaska transfers and those from outside of the University of Alaska.

Because the data for this section was just obtained, the text and tables are not yet complete.

Appendices

The report also includes a standalone volume of appendices, including:

Appendix A: Engineering Expansion Initiative

Appendix B: Engineering Specialties

Appendix C: University of Alaska Anchorage, Space Database

Appendix D: University of Alaska Fairbanks, Space Database

Appendix E: University of Alaska Anchorage, Course Schedule, Fall 2009, and Course Block Diagrams

Appendix F: University of Alaska Fairbanks, Course Schedule, Fall 2009, and Course Block Diagrams

Appendix G: University of Alaska Engineering First-Time Freshmen by High School and Fall Term

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Executive Summary

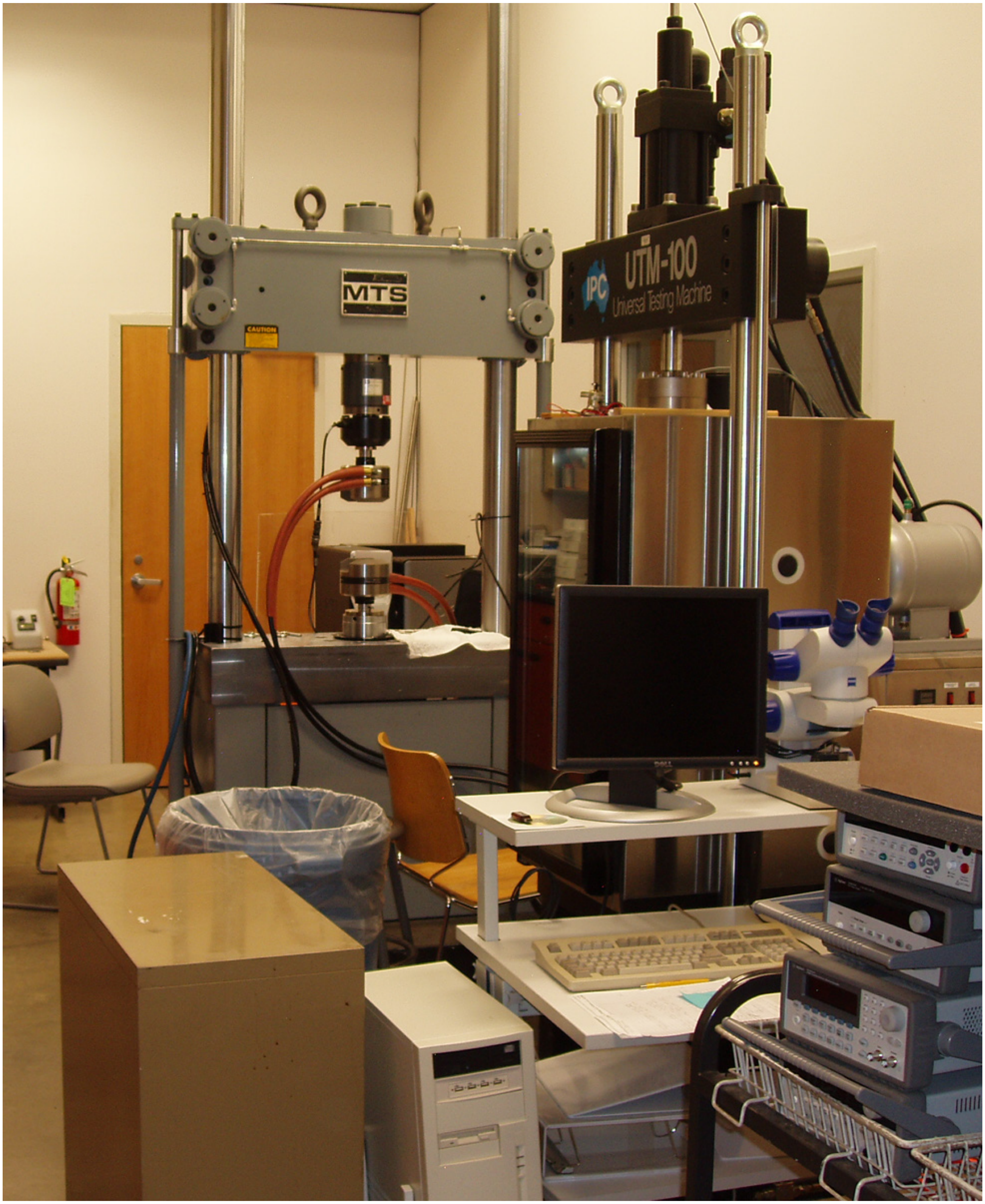
Introduction

Facilities

Progress Report on the Regents' Engineering Expansion Initiative

Summary of Major Findings

What Engineers Do



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UAA, Engineering Building, Room 101B, Crews Laboratory. This laboratory houses the MTS and Instron equipment for stress and strain testing and measurement. In 2006, the laboratory was named after supporter Paul Crews, a long-time mechanical engineer in Alaska and one of the first licensed professional engineers in Alaska.

EXECUTIVE SUMMARY

The Executive Summary describes the Engineering Plan 2010. It also provides a summary progress report card on how well each of the objectives of the Board of Regents' 2007 Engineering Expansion Initiative has been met. Lastly, a summary of the major findings of the study is provided.

A. INTRODUCTION

What is the University of Alaska Engineering Plan 2010?

The University of Alaska Engineering Plan 2010 is a report that is:

- An analysis of how well the objectives outlined in the Board of Regents of the University of Alaska Engineering Expansion Initiative adopted in 2007 have been met.
- An omnibus indicators report bringing together many details about engineering education and engineering employment in the State of Alaska.
- A summary of projected engineering enrollments and graduates and the resultant critical need for facilities to support meeting the Regents' goals in engineering education.
- A statement of the importance that engineers have in the economic vitality of the State of Alaska and the vital role the University of Alaska has in helping to meet the demand for engineering employment in the State.

The surge in demand for an engineering education at the University has resulted in a 50 percent increase in engineering enrollments at the University of Alaska Anchorage and the University of Alaska Fairbanks in the past four years. This rapid growth has not been accompanied by any increases in permanent facilities for engineering at either campus. This growth has taxed the existing facilities and resulted in significant engineering program space deficits at both campuses that needs to be resolved.

The percentage of Alaska high school graduates who now enter UAA and UAF as first-time freshmen majoring in engineering has doubled since 2005. Both campuses work with their local high schools to encourage students to enroll in engineering and these efforts are paying off.

Employers of engineers in Alaska interviewed for this study consistently stated their preference to hire engineers educated in Alaska. They indicate that those who have grown up in Alaska or who have gone to school in Alaska understand what it is like to work in the State. In contrast, they state that others often come to work in Alaska, but many leave after a year or two.

B. FACILITIES

Unstated Outcome

An unstated, but understood, outcome of the Engineering Expansion Initiative was to make the connection between the Board of Regents approved initiative and the facilities that would need to be constructed to meet the Initiative goals. This includes:

- Provide data about facilities that supports campus needs.
- Develop metrics that show any deficiencies that need to be overcome to reach the target of 200 trained engineers and 140 engineering-related graduates.
- Identify what has to be in the "growth" pipeline (faculty, students, staff) to reach the target set in the Regents' Engineering Initiative.
- Identify if there should be unlimited growth in the engineering programs, beyond the stated goals.

Existing Facilities

As noted in the University of Alaska Request for Proposals for the UA Engineering Plan 2010 study, the existing engineering buildings, at both UAA and UAF, are more than 30 years old, are under sized, and do not contain appropriate laboratories for undergraduate programs. A critical need exists for expanded teaching and research laboratory space as programs on both campuses continue to grow. Changes to successful instructional methods place a greater emphasis on "hands-on" opportunities for undergraduate students.

New Facilities

At the June 4, 2010 Board of Regents meeting, the Board approved requests for two University of Alaska engineering building projects that were in compliance with the UAA and UAF Campus Master Plans and authorized the university administration to proceed with project development in compliance with the University of Alaska Academic Master Plan through schematic design.

Both UAA and UAF envision construction of new facilities for engineering that will allow their respective engineering programs to provide space adequate to educate students to meet the State of Alaska's need for additional engineers.

The University has stated that before the major academic units proceed with design and construction of their new buildings, the Engineering Plan 2010 will confirm the statewide facility need to accommodate delivery of current engineering programs at each campus and the Board of Regents approved targets for graduates. Moreover, the Engineering Plan 2010 must comply with the draft University of Alaska Academic Master Plan (AMP), which is in the final stage of being adopted, and also comply with the adopted Campus Master Plans.

The Importance of Engineers

While much of this study provides data and indicators about historical engineering enrollments and projections of future enrollments at the University of Alaska, the untold story of this study is the importance of a trained engineering workforce to the economy of the State of Alaska. Engineers are needed to fill both new positions in the State due to growth and to replenish an existing labor force that changes due to retirement, death, and new job opportunities. The State of Alaska's occupational forecast for engineers from 2008 to 2018 shows more than two replacement job openings for every new engineering job opening. In engineering-related fields, there are nearly three job openings due to replacement for every new job created due to growth.

The three largest expected areas of engineering growth in Alaska to 2018 are: civil engineering, with 100 new positions and slightly more than 100 replacement positions for a total projected employment in 2018 of 800; petroleum engineering, with a growth of 50 positions and replacement of nearly 200 for a total 2018 employment of slightly more than 500; and, mechanical engineering, projected to grow by 17 throughout the State with another 83 replacement jobs. Overall, the State estimates there will be slightly more than 300 mechanical engineers employed in the year 2018.

And, despite the increases in the number of students who are receiving engineering degrees, and thus an increase in supply, the demand for those in engineering outstrips the supply. The National Association of Colleges and Employers (NACE) winter 2010 survey issued in March 2010 showed eight of the top ten college degrees by highest starting salary to come from engineering. Topping the list were students with degrees in petroleum engineering.[1]

B. PROGRESS REPORT ON THE REGENTS' ENGINEERING EXPANSION INITIATIVE

The following is a report card on how well each of the objectives in the Board of Regents' 2007 Engineering Expansion Initiative has been met. The complete Engineering Expansion Initiative is contained in the appendix to this study.

- **Objective: By 2012, UAA and UAF will produce 200 undergraduate trained engineers annually.**

  In spring 2007, the year the Regents' Initiative was adopted, 72 students with baccalaureate engineering degrees graduated from the University of Alaska. UAA graduated 27 students with baccalaureate engineering degrees and UAF graduated 45 students. By spring 2010, engineering graduates at UAA had increased to 71 and at UAF to 77, for a total of 148 graduates. While the campuses combined will not quite meet the Regents' target of 200 graduates per year by 2012, the Regents' target of 200 undergraduate trained engineers will be achieved by the year 2014.

1 "10 Highest Paying Degrees 2010 – Best Majors in Demand Now" http://www.darwinsfinance.com/top-10-college-degrees-2010-best-majors/, accessed November 7, 2010

- **Objective: By 2012, produce 20 baccalaureate construction manager graduates and train 40 to 60 certificate and two-year construction technology program graduates annually.**

  In spring 2010, there were no baccalaureate degrees awarded by the University of Alaska in construction management. While there were 99 students enrolled in the BS degree in construction management at UAA in 2009, the program has not been in existence long enough to produce any graduates. The newly approved UAF BS degree in construction management has just started and also has not yet produced any graduates. Although there have been no baccalaureate graduates to date, it is possible by the year 2012 that UAA will produce 20 construction management students in this program based on current student enrollment.

  In fall 2009, there were 36 students enrolled in the associate's degree program in construction management at the UAA Community and Technical College and 34 in the Associate of Applied Science degree in construction management program at the UAF Community and Technical College (Tanana Valley Community College). By spring 2010, there were three graduates in the UAA program and six in the UAF program. While enrollments in the program have increased, and nine graduates completed the program in spring 2010, it is likely there will be at least that many graduates in 2012, but perhaps not the 40 to 60 certificate and two-year degree students identified in the Regents' objective.

- **Objective: By 2012, including the 200 undergraduate trained engineers, produce a total of 340 graduates in engineering-related programs from certificate and associate to Ph.D. level programs.**

  In spring 2010, UAA granted three one-year certificates, two two-year AAS associate's degrees, and 41 master's degrees. Also in spring 2010, UAF granted 24 master's degrees and three Ph.D.'s. Altogether, there were a total of 74 engineering-related certificates, associate's degrees, master's, and Ph.D.'s awarded at UA in 2010. If 60 to 80 construction management and certificate degree program graduates can also be achieved, then it is likely the remaining 60 to 80 degree students needed to meet the Regents' targets for graduates of engineering-related programs will be met by 2012.

- **Objective: Increase the number of project management certificate and master's degree recipients.**

  The number of project management master's degrees awarded at UAA has increased from 14 in spring 2007 to 27 in spring 2010. Other master's degrees awarded declined slightly during the same period from 21 in 2007 to 14 in 2010. At UAF, the number of master's degrees awarded declined from 28 in spring 2007 to 24 in spring 2010.

- **Objective: Increase the number of students graduating from Alaska high schools who desire a career in engineering.**

  At UAA, the number of first-time baccalaureate degree-seeking freshmen increased from 43 in fall 2007 to 61 in fall 2009, including 50 who were graduates of public high schools in Alaska and three who were graduates of non-public high schools. At UAF, the number of first-time baccalaureate degree-seeking freshmen increased from 97 in fall 2007 to 104 in fall 2009. Among the 104 students were 91 graduates of public high schools in Alaska and three who graduated from non-public Alaska high schools. In addition, many Alaska high school graduates who leave the State to start their higher education degree program return to Alaska to complete the degree. On average, over the past ten years, 12 percent of students entering engineering at UAA and 14 percent at UAF had started their higher education elsewhere and transferred to UA. More than one-half of these transfer students were Alaska high school graduates.

- **Objective: Expand engineering research capacity and over the next four years increase engineering-related research by 50 percent from $18 million to $27 million per year annually.**

The Regents have indicated that UAF is the UA campus for which sponsored research is a primary mission. The Institute of Northern Engineering (INE), the research wing of the UAF College of Engineering and Mines, has reached a plateau in research at approximately $18 million per year. A major limitation on expanding research is the lack of additional research facilities.

UAA faculty also compete for research grant funding. UA grant fund research totaled $447,000 in 2008-09 and $762,000 in 2009-10.

Space for faculty research as a component of their workload, at both UAA and UAF, is included in the space projections contained in this study.

- **Objective: Expand professional development opportunities for existing professionals as required for the maintenance of their professional engineering (PE) license.**

Neither UAA nor UAF currently offer continuous continuing education programs providing CEU credits for the professional engineering license in Alaska, although CEU credit courses are offered on an irregular basis. Some faculty are guest speakers at the professional engineering association's meetings for which attendees receive partial CEU credit. Much of the engineering CEU credits are generated online by agencies, organizations, and employees themselves who provide the for-credit CEU programs in Alaska.

- **Objective: Develop 1+3 programs in Juneau, Mat-Su, Kenai, and other UA community campuses as first-year feeder programs.**

Currently, only the Juneau campus has developed a 1+3 program as a feeder program. In fall 2009, there were seven students enrolled in this program and one faculty at UA Southeast. At the same time, over the past ten years, 81 students have transferred from a UA community college to an engineering program at UAA or UAF.

- **Objective: Increase the number of scholarships available to engineering students reaching senior status in time to graduate within five years.**

To be completed.

- **Objective: Develop centers of excellence in niche disciplines such as energy, arctic engineering, and transportation through establishing ten named professor positions.**

  To be completed.

Reaching the Regents' Engineering Initiative Objectives

Overall, UAA and UAF have done an outstanding job in increasing undergraduate engineering enrollments leading to more students completing a BS degree in engineering. At the same time, while the persistence rate of these students has improved, it is likely that up to 50 percent of students entering or transferring into engineering will drop out and not complete a degree in engineering. Some of the students, approximately ten percent, will transfer to other University of Alaska programs and graduate from them. Others will choose a different career path.

Due to the increased interest in engineering and using conservative estimates of combined increases in enrollment, the University will be graduating a total of 200 Bachelor of Science engineering graduates per year by the year 2014. Due to the impending decline in the number of Alaska high school graduates, the engineering programs at UAA and UAF may begin to level off in undergraduate enrollment based on projecting current rates of enrollment and retention.

Another important item has occurred since passage of the Regents' Engineering Expansion Initiative. ABET, Inc. (formerly the Accreditation Board for Engineering and Technology) has indicated to the University of Alaska Anchorage that faculty and facility shortages threaten UAA engineering accreditation.

C. SUMMARY OF MAJOR FINDINGS

Listed below is a summary of the major findings of the UA Engineering Plan 2010 study. For organizational purposes, the findings are organized into the following topical areas: enrollments, graduates, employment, faculty, space, and retention.

Enrollments

- **Baccalaureate Enrollments:** Baccalaureate enrollments at the University of Alaska have surged since the passage of the Regents' Engineering Expansion Initiative in 2007. At UAA, BS degree enrollments have increased from 444 in fall 2007 to 535 in fall 2009. Preliminary fall 2010 BS enrollments at UAA have reached 642 (excluding Geomatics). At UAF, BS enrollments have increased from 401 in fall 2007 to 549 in fall 2009. Preliminary fall 2010 BS enrollments at UAF have reached 576.

- **Graduate Degree Enrollments:** Graduate degree enrollments have also increased. At UAA, master's degree enrollments increased from 176 in fall 2007 to 203 in fall 2009. At UAF, master's degree enrollments have increased from 89 in fall 2007 to 94 in fall 2009. Doctorate enrollments at UAF increased from 26 to 30 during the same period.

- **Engineering-Related Enrollments:** Enrollments in licensure programs, certificates, associate degree programs, and pre-majors also increased substantially. At UAA, enrollments in these areas increased from a total of 124 in fall 2007 to 184 in fall 2009. At UAF, these enrollments declined slightly from a total of 53 in fall 2007 to 45 in fall 2009.

Projected Baccalaureate Enrollments

- **Projected Enrollments:** At UAA, baccalaureate degree enrollments have increased an average of 17 percent per year from fall 2002 to fall 2009. Using a conservative estimate of a ten percent per year average increase, baccalaureate enrollments in engineering at UAA could increase to 547 in fall 2010, 601 in fall 2011, and 662 in fall 2012. At UAF, baccalaureate enrollments have increased at an average of eight percent per year from fall 2002 to fall 2009. Using a conservative average annual increase of five percent per year, baccalaureate enrollments at UAF could increase to 576 in fall 2010, 605 in fall 2011, and 636 in fall 2012. The increases in enrollment do not of themselves necessarily represent program growth. Accompanying the recent increases in enrollments was a substantial increase in the number of students classified as seniors. At UAA, between 2006 and 2009, the number of seniors in the engineering baccalaureate programs increased by 113 students, or one-half of the enrollment increase. At UAF, during the same time, the number of seniors increased by 77 students, or slightly more than one-third of the total BS enrollment growth.

Graduates

- **Baccalaureate Engineering Degrees:** The number of students graduating in University of Alaska engineering programs has increased substantially since fall 2007. At UAA, baccalaureate engineering degrees increased from 35 in spring 2008 to 71 in spring 2010. At UAF, baccalaureate engineering degrees increased from 46 in spring 2008 to 77 in spring 2010. There were a total of 148 baccalaureate engineering degrees in spring 2010 at UA.

- **Degree Increases:** Based on historical enrollments and projections in the Engineering Plan 2010, baccalaureate engineering degrees are expected to increase to 103 by spring 2014 at UAA and to 99 by spring 2014 at UAF. The Regents' target of 200 undergraduate baccalaureate degrees being awarded at the University of Alaska should be reached in spring 2014.

- **Engineering-Related Degrees:** Increases in degrees and certificates in engineering-related fields, including master's degrees, have not had the same surge as bachelor's degrees. At UAA, engineering-related degrees increased from 49 in spring 2008 to 52 in spring 2010. At UAF, engineering-related degrees and certificates declined from 41 in spring 2008 to 27 in spring 2010.

- **Community College Engineering-Related Enrollments:** Engineering-related major enrollment at the UA Community and Technical Colleges increased dramatically since passage of the Regents' Engineering Expansion Initiative. Engineering-related enrollment at the UAA Community and Technical College increased from 103 in fall 2007 to 188 in fall 2009. At the UAF Community and Technical College (Tanana Valley Community College), engineering-related enrollments increased from 112 in fall 2007 to 222 in fall 2009.

- **Community College Engineering-Related Degrees:** Engineering-related degrees awarded at the UA Community and Technical Colleges have not yet matched the growth in enrollment. At the UAA Community and Technical College, degrees awarded in Architectural and Engineering Technology and in Construction Management remained flat at 17 in spring 2008 and 17 in spring 2010. At the UAF Community and Technical College, associate degrees in Construction Management increased from one in spring 2008 to six in spring 2010.

Employment

- **Projected Engineering Employment Increases:** Based on data from the State of Alaska Department of Labor and Workforce Development, the number of engineers in Alaska is expected to increase from 3,782 in 2008 to 4,121 in 2018, or a ten percent change.
- **New and Replacement Engineering Jobs:** The State projections indicate that in addition to the nearly 340 new engineering jobs projected over the next ten years, there will also be 877 replacement job openings for a total of 1,246 projected jobs in engineering. This amounts to approximately 120 engineering job openings per year to the year 2018.
- **Projected Engineering-Related Jobs:** In engineering-related jobs, including drafting, technicians, cartography, the State estimates there were 3,128 employed in these areas in 2008. The State projects this employment could increase to 3,470 by 2018, or a growth of 342 new engineering-related jobs.
- **Replacement Engineering-Related Jobs:** The State projects that in engineering-related fields, there will also be a demand for 900 replacement workers in the next ten years.
- **Total Engineering-Related Jobs:** Taken together, with new jobs and replacement jobs, there will be approximately 1,242 engineering-related job openings in the State between 2008 and 2018. This amounts to approximately 120 jobs per year.

Faculty

- **UAA Engineering Faculty:** At the UAA School of Engineering, there are currently 27 full-time, regular-rank headcount faculty, five full-time temporary or term faculty, and 29 part-time faculty. This is equivalent to 38.5 FTE faculty.
- **UAF Engineering Faculty:** At the University of Alaska Fairbanks, there are 44 full-time, regular-rank headcount faculty, one part-time headcount faculty, five full-time temporary or term faculty, and nine part-time headcount faculty. This amounts to 43.5 FTE faculty.

Facilities Space

- **UAA Engineering Space Total:** The University of Alaska Anchorage School of Engineering occupies 40,664 assignable square feet in seven separate buildings. Of this space, 14,996 square feet is in the Engineering Building on the UAA campus, 313 square feet is in an Engineering Greenhouse on the UAA campus, and 10,297 square feet of the remaining 25,355 assignable square feet is leased space, some of which is approximately two miles from the UAA campus.

- **UAA Engineering Space Net:** When the temporary lease space is reduced from the UAA School of Engineering space, the School has 15,309 assignable square feet, or approximately 25,500 gross square feet.
- **Distribution of UAA Engineering Space:** Of the UAA space, both on-campus and in leased buildings, the current distribution of School of Engineering space is approximately 39 percent class laboratories, 39 percent office space, and the remainder in study space, special use, support, and research.
- **UAF Engineering Space Total:** At the University of Alaska Fairbanks, the primary space for the College of Engineering and Mines is in the Duckering Building. There is a small amount of space in the MIRL Building as well. Altogether, the UAF College of Engineering and Mines has a total of 47,071 assignable square feet, or approximately 78,452 gross square feet.
- **Distribution of UAF Engineering Space:** Of the UAF space, the current distribution of College of Engineering and Mines space is approximately 63 percent class laboratories, 30 percent offices, and remainder in study space, special use, support, and research.
- **UAA Existing Space per Faculty:** With a faculty headcount of 38.5 FTE, UAA has, including campus space and leased space, approximately 1,056 assignable square feet per faculty.
- **UAF Existing Space per Faculty:** With a faculty of 43.5 FTE, UAF has currently an average of 1,082 assignable square feet per engineering faculty.
- **UAA Engineering Space Needs Projection:** For projection purposes, space needs were projected for both campuses at 1,676 asf per faculty based on a benchmark analysis of ten other schools and colleges of engineering. Based on this benchmark, the UAA School of Engineering should have 64,526 asf (107,543 gross square feet) of space. With its current existing space of 15,309 square feet, and the ability to gain back 4,278 square feet used for other programs in the UAA Engineering Building, the current space deficit for engineering at UAA is 44,939 asf, or about 74,898 gross square feet. Registrar-assigned classroom space used by UAA would add another 2,194 asf (3,657 gross square feet). The total space needs deficit is 78,555 gross square feet.
- **UAF Engineering Space Needs Projection:** At UAF, the 43.5 faculty at 1,676 asf per faculty would lead to a current space need of 72,906 asf. Deducting the current CEM space of 47,071 square feet leaves a CEM space deficit of 25,835 asf, or about 43,058 gross square feet. With the addition of Registrar-assigned classroom space of 6,730 square feet, the total UAF CEM space needs is 32,565 asf, or about 54,275 gross square feet.

Retention

- **Graduating in Engineering:** Not all students who enter engineering complete their degree. Based on historical data, it is estimated that approximately 50 percent of students entering engineering programs over the past ten years have or will graduate in engineering. Another ten percent will change their majors and graduate with another degree from the University of Alaska. About 40 percent of engineering students will drop out.
- **Time to Degree, UAA Engineering:** The time needed to complete a degree for engineering is longer, in general, than the four years that it would minimally take. At the University of Alaska Anchorage,

from the years 2000 to 2002, six percent of entering first-time, full-time freshmen baccalaureate engineering students who could have graduated in four years did so. By five years, 14 percent had graduated and by eight years, 20 percent had graduated.

- **Time to Degree, UAF Engineering:** At the University of Alaska Fairbanks, from the years 2000 to 2002, 11 percent of entering first-time, full-time freshmen baccalaureate engineering students graduated in four years. By five years, 21 percent had graduated and by eight years, 28 percent had graduated.

D. WHAT ENGINEERS DO

What Engineers Do

According to the U.S. Bureau of Labor Statistics, the nature of the work that engineers do is the application of the principles of science and mathematics to developing economical solutions to technical problems. It is work that serves as the link between scientific discoveries and the commercial applications that meets societal and consumer needs.[2]

As noted by the Bureau of Labor Statistics, many engineers develop new products. In addition to their involvement in design and development, other engineers work in testing, production, or maintenance. Engineers in management are responsible for major components for entire projects. Engineers may also work in an industry, such as oil and gas, or in a type of technology, such as turbines or semiconductor materials.[3]

Most engineers specialize. The federal government's Standard Occupational Classification (SOC) system identifies 17 separate identifiable engineering specialties. These specialties, and descriptions of each, are shown in the appendix. In addition, many other specialties are recognized by professional engineering societies and each of the major branches of engineering has numerous subdivisions.

The Education of Engineers

As noted by the Bureau of Labor Statistics, a bachelor's degree in engineering is required for almost all entry level engineering jobs. Most engineering degrees are granted in electrical and electronics engineering, mechanical engineering, and civil engineering. This is true in Alaska and in all states. The broad education of engineers allows employers to meet staffing needs in which engineers may be in short supply. It also allows engineers to shift to fields with better employment prospects.

Engineering degree programs involve a concentration of study in an engineering specialty, along with courses in mathematics and the physical and life sciences, as well as courses in general engineering.

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2 Bureau of Labor Statistics, United States Department of Labor, *Occupational Outlook Handbook, 2010-11 Edition.* http://www.bls.gov/oco/ocos027.htm, accessed November 7, 2010

3 Bureau of Labor Statistics, United States Department of Labor, *Occupational Outlook Handbook, 2010-11 Edition.* http://www.bls.gov/oco/ocos027.htm, accessed November 7, 2010

The Accreditation Board for Engineering and Technology (ABET) accredits college and university programs in engineering and engineering technology. ABET accreditation is based on a program's faculty, curriculum, and facilities; the achievement of a program's students; program improvement; and institutional commitment to specific principles of quality and ethics.[4] All of the undergraduate engineering programs at the University of Alaska Anchorage and the University of Alaska Fairbanks are ABET accredited.

Not all students who enter into engineering degree programs complete them. While the University of Alaska engineering programs of study are designed to be completed in four years, many students take considerably longer to complete their engineering degree. The progress toward completing a degree is highlighted in this study. Both in Alaska and nationwide, only one-half of those who enter engineering complete their degree requirements.

Employing Engineers in Alaska

Employers in Alaska take different approaches in their hiring of an engineering staff. Those firms involved in design hire students immediately upon graduation, often taking the opportunity to work with the students through an internship with their company. Other companies and agencies that employ engineers require them to have advanced management skills that can only be obtained from experience by working in the field. Some of these firms hire permanent employees by first engaging contract employees as a testing period while others employ a broad, widely advertised recruiting process, and then select from among the applicants.

The firms that hire newly graduated engineers add to the engineer's education by providing training within their firms. Those whose hiring preferences and needs are for a highly trained engineer also augment their employee's education by paying for the cost of obtaining an advanced degree, most often in project management. The University of Alaska Anchorage master's degree program in Project Management was often mentioned in the employer interviews.

Licensure

Alaska, along with the other 49 states and the District of Columbia, require engineers to be licensed when they offer their services directly to the public.[5] Those who are licensed are identified as professional engineers. Not all students who graduate become professional engineers; not all employers require their engineering employees to be licensed professional engineers. In data prepared by the State of Alaska for this study, it was determined that one of six individuals who graduated in engineering from the University of Alaska in the last ten years and is currently employed (other than self-employment) in Alaska is a professional engineer licensed in Alaska.

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4 Bureau of Labor Statistics, United States Department of Labor, *Occupational Outlook Handbook, 2010-11 Edition.* http://www.bls.gov/oco/ocos027.htm, accessed November 7, 2010

5 Bureau of Labor Statistics, United States Department of Labor, *Occupational Outlook Handbook, 2010-11 Edition.* http://www.bls.gov/oco/ocos027.htm, accessed November 7, 2010

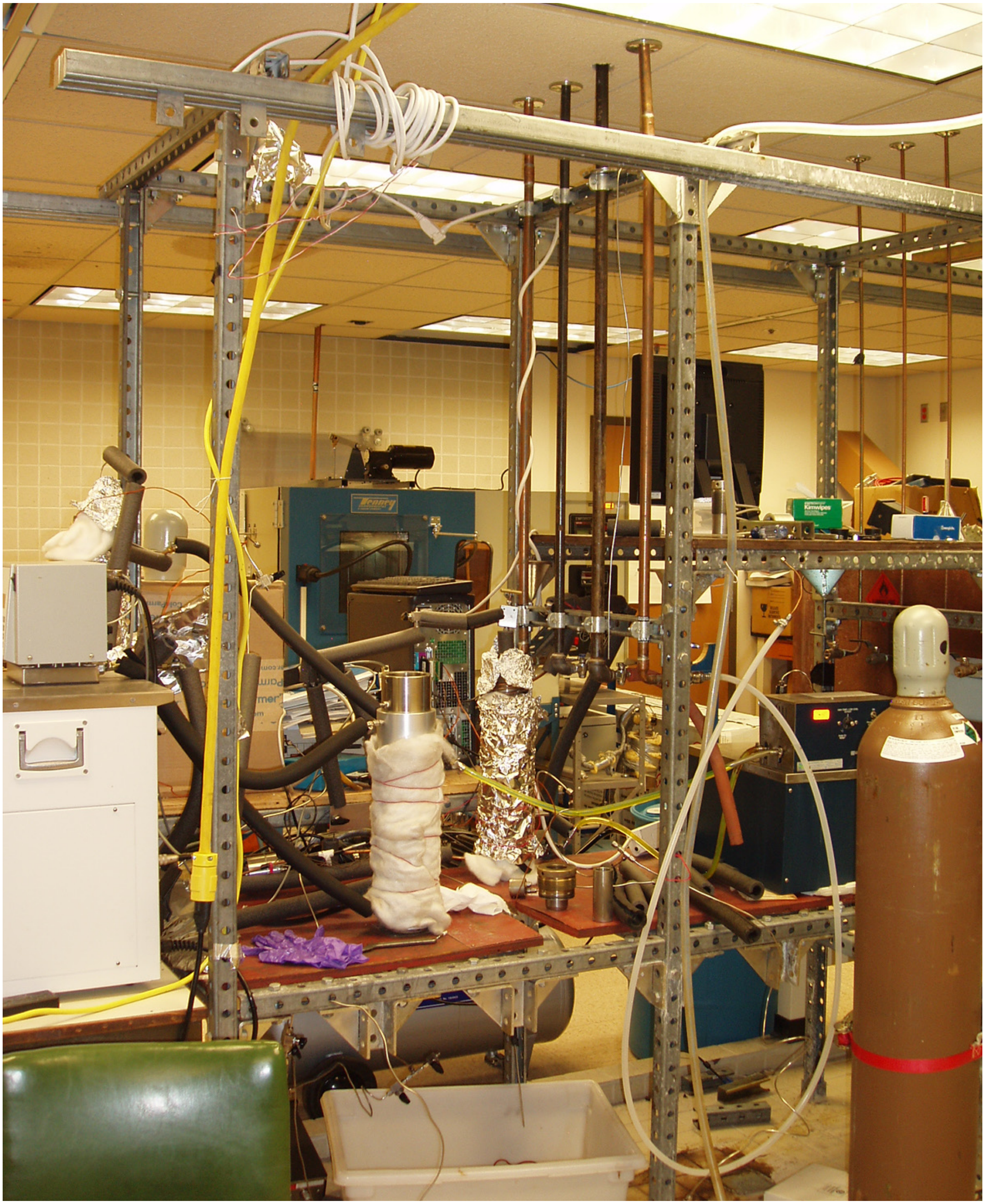
Facilities

The academic education of engineers occurs both in the classroom and in the teaching or class laboratory. As this study describes, the class laboratory facilities at both UAA and UAF are limited in terms of the space needed for the hands-on education that engineers require. In some cases, the laboratories themselves are dated.

The recent surge in engineering enrollments at the University of Alaska has led to a critical need for expanded teaching and research laboratory space as programs on both campuses continue to grow, as this report indicates.

R

Recommendations



Ira Fink and Associates, Inc.

UAF, Duckering Building, Room 434. This room is the UAF Petroleum Engineering Department's gas hydrate lab. This laboratory is capable of conducting gas hydrate core studies and measurement of thermodynamic and kinetic properties of gas hydrates. The equipment shown in this photograph includes: gas hydrate coreholder, RTE 4- Neslab refrigerated bath circulator, temperature controller, gas compressor, air compressor, Jerguson liquid level gauges (2), vacuum pump (2), Beckman conductivity meter, steam generator, Omega temperature readout device, Heise pressure gauges (5), transfer cell, Zeiss scope, Exatroll controller/programmer, wet test flowmeter, freezer chest, Crycool CC100 immersion cooler, rocker with controller and methanol-insulated bath.

RECOMMENDATIONS

While there has been success and accomplishment in meeting the objectives of the Regents' Engineering Expansion Initiative, a number of challenges still exist. The following recommendations, if accepted and adopted, will form the basis for a plan for engineering at the University of Alaska for the following decade.

1. Bachelor of Science Degrees: UAA and UAF should maintain a minimum of graduating 200 undergraduate trained engineers annually.

While the target number of 200 Bachelor of Science degree engineers annually will vary from year to year, it is a realistic target given the likelihood of a decline in high school graduates in the State of Alaska and the continued projected demand for engineers in the State.

From 2004 to 2006, UAA and UAF combined graduated an average of 70 Bachelor of Science students in engineering annually. From 2007 to 2009, this increased to 82 Bachelor of Science degrees in engineering annually. In 2010, 148 BS degrees in engineering were awarded.

The number of Bachelor of Science degrees in engineering is expected to reach 200 per year in 2014 at current enrollment levels and stay at or above that level through the end of the decade. This would result in approximately 2,000 undergraduate engineering degrees being awarded through the year 2020. This is consistent in meeting workforce needs for engineers in Alaska, with the State of Alaska occupational forecast of 1,610 new and replacement job openings for engineers in the State from 2008 to 2018.

2. New Facilities: UAA and UAF should begin detailed facility programming and conceptual design for new engineering buildings on their campuses.

A major challenge to the UAA and UAF programs is the inadequacy of space devoted to engineering in general and engineering teaching laboratories in particular. As the photographs in this report indicate, the engineering laboratories themselves are cramped and full. Providing adequate space for hands-on learning, for the ability to set up and maintain projects, and for the opportunity to be in the laboratory in off hours, constitute opportunities that cannot be had at present because of the lack of space.

The facility needs in engineering for both UAA and UAF are well documented throughout the study. Although total engineering enrollments have increased between 2006 and 2009 at both UAA and UAF by more than 40 percent, and undergraduate baccalaureate engineering degree enrollments have increased by 95 percent at UAA and 64 percent at UAF, neither campus has had an increase in new, permanent facilities. The facilities situation has become critical at both campuses.

UAA operates in a single on-campus engineering facility as well as using classroom space throughout the campus and student project space in leased space two miles from campus. UAA needs better facilities and dedicated engineering class laboratories. The UAF facility, also in a single building, is shared with its research enterprise. While this allows students the opportunity to see and participate in research firsthand, the equipment required for an engineering education means the class laboratories themselves are crowded and need space.

This study calculates the space deficit at UAA SOE to total 44,939 assignable square feet (asf) (74,898 gross square feet). This is in addition to the existing School of Engineering space, which totals 15,309 asf (25,515 gsf) plus an additional 4,278 asf (7,130 gsf) from space in the UAA Engineering Building that is currently assigned to the College of Health and Social Welfare for the WWAMI medical program.

At UAF, the CEM space deficit is computed to be 25,835 asf (43,058 gsf). This is in addition to the 47,071 asf (78,452 gsf) of existing CEM space and 6,730 asf (11,217 gsf) of Registrar-assigned classrooms.

Both campuses need to develop comprehensive programmatic statements of their facilities needs by further defining instructional spaces to be provided in the new facilities, the student capacity of these spaces, and their size (area) based on the equipment or furniture needed in the instructional spaces. At the same time, both campuses need to chart their expected utilization of the instructional spaces in these facilities based on the number and type of course offerings that could be conducted in each of the teaching spaces to assure they are adequately utilized.

Because of the complexities of engineering instructional spaces and laboratory buildings, these programmatic studies need to be entered into conceptual design to assure code, cost, and operational issues are analyzed.

In addition, neither of the currently developed facility program statements by UAA or UAF provide much public or student free-time, drop-in space. More detailed programmatic analyses of the types and configuration of both in- and out-of-classroom and class laboratory instructional and free-time space is needed.

Neither the UAA nor the UAF current facility program statements fully define the types and sizes of the spaces or their individual room station capacity. The facility programming documents for the UAA and UAF engineering buildings should provide details and document not only the individual space needs of the buildings, but how these needs can best be met for both undergraduate and graduate programs. Both documents should include construction and project cost totals and cost details.

UAA and UAF need to thoroughly review the programs proposed for their new engineering facilities. Both campuses need to test the facility programs against the number of students that can be accommodated in the laboratories they are proposing. Both need to illustrate how technology can be used in the laboratory setting and even dedicate space for lecture capture and recording. Both facility programs need to be revisited in view of what this study has illustrated to the Steering Committee and Advisory Boards regarding an engineering education. Both campuses need to examine more closely what is needed to support an engineering education well into the future. This future look must also serve to overcome unmet current needs and translate these needs into specific building programs, based in part on the equipment and furniture needed in the class laboratories, and based in part on the average class size enrolled in the laboratory courses.

Both the UAA and UAF facility programming studies need to include existing space that is to be reused and perhaps reassigned, as well as new space. This includes a review of what program spaces are best suited to new facilities and those that can best be accommodated in existing space. The existing space analysis needs to include building code review as standards and requirements have changed since the existing facilities were first put into use. In other words, the programmatic studies need to be comprehensive, as well as opportunistic, to ensure efficiency and effectiveness in the use of new space and the reuse of existing space.

3. Retention Rate: UAA and UAF should work diligently to reduce the dropout rate of students entering engineering with a target of 50 percent of students entering into baccalaureate engineering degree programs graduating in engineering at UAA and 60 percent at UAF.

Historically from 2000 to 2005, approximately 50 percent of the first-time, full-time freshmen entering the engineering programs at UAA and UAF dropped out. Some left after their first year, some after their second year, and some throughout the continuation of their academic stay at the University of Alaska often extending into years seven and beyond. During this time, the retention rate from first to second year among these students was approximately 75 percent, with 25 percent dropping out. Likewise, among first-time, full-time freshmen engineering students entering the program from 2006 to 2009, the freshmen to sophomore retention rate has remained in the 75 percent range, with approximately 25 percent of the students dropping out. However, if past performance is an indication, then approximately 25 percent more of these students will drop out within the next two to seven years and not complete their degree. Of the 50 percent who drop out of engineering, 10 percent transfer to another program at the University and graduate with a non-engineering degree and the other 40 percent leave UA.

Increasing the graduation rate of engineering students from 50 percent to 60 percent would have the dual effect of reducing the burden on other programs of the UAA and UAF campuses since one-half of the dropouts occur during the freshman year. During the freshman year, engineering students take only about one-third of their required coursework in engineering, while other departments on campus are responsible for much of the instruction of freshmen engineering students, in courses including math, English, chemistry, and physics.

Increasing the retention and graduation rate of engineering students would also have the benefit of increasing the number of engineering graduates per class cohort, both as a percentage of students in the cohort and as an absolute number of students graduating, thus allowing program growth to occur with less need to add yet more new facilities. Studies of engineering student success have also shown that the availability of engineering facilities, which allows entering students the opportunity to work on projects while problem solving, increases their opportunity for educational success.

Research has shown that undergraduate success in engineering is enhanced by undergraduates engaged in research projects, students active in engineering-based activities and organizations, and attention being paid to individual students' academic needs. Providing these activities requires both facilities and funding.

A 10 percent year over year reduction in students dropping out would, within five years, have the same net effect as enrolling 50 more undergraduate at UAA and 100 more at UAF.

4. Time to Graduate: UAA and UAF should make internal changes necessary to minimize the time to graduation for students entering the Bachelor of Science in Engineering programs at the campuses.

Currently, about one-half of the students entering engineering programs at UAA and UAF graduate within four to eight years of their enrolling. Of the remaining 50 percent, about 10 percent transfer into other degree programs at UAA and UAF and graduate. And, as noted above, the remaining 40 percent of students who enter engineering drop out.

Additional academic support services to students in engineering, including tutoring, would assist students in completing their engineering degree in five years, or six years at the outset. The major impact of decreasing the time to graduation would primarily be seen in a significant reduction in the size of the senior classes at both UAA and UAF, where currently there are two to three times as many senior level students in comparison to first-time freshmen. As the engineering enrollments have increased dramatically over the past few years, the number of seniors who do not graduate has grown disproportionately.

Some of the growth in senior class level students is due to a need for the student to complete a specific required course or courses before graduating. For others, they are employed while going to school, and completing their degree on a part-time basis keeps them enrolled for a longer period of time.

The more efficient progress toward graduation of students entering engineering would have multiple impacts: first, it would reduce the number of students in the engineering program and lessen the long-term facilities needs and faculty and staffing demands of programs that take longer than six years for many student to graduate. Second, it would assist students by allowing them to enter the full-time workforce earlier. Third, it would assist students who borrow money to complete their education by reducing the length of time they are in school and thus the amount of money they are borrowing.

The combined reduction in time to degree, with a corresponding potential leveling in enrollments, would have the win-win impact of more engineering students graduating within a smaller class cohort. This in turn would lessen the long-term facilities demand created by students both dropping out and taking an inordinate length of time to complete their degree and graduate.

5. Program Size: UAA and UAF should recognize that their baccalaureate program enrollments will not expand indefinitely and will begin to level off.

At UAA, baccalaureate degree engineering enrollments increased from 255 majors in fall 2006 to 497 in fall 2009. Although this undergraduate enrollment nearly doubled, the number of entering first-time engineering freshmen enrollment at UAA remained almost constant at 59 in fall 2006 and 61 in fall 2009. During the same time, the number of seniors enrolled in the UAA engineering program increased by 113 from 89 in fall 2006 to 202 in fall 2009.

At UAF, baccalaureate degree engineering enrollments increased from 335 majors in fall 2006 to 549 in fall 2009. During this time, first-time freshmen engineering enrollments at UAF increased by 46 students from 58 in fall 2006 to 104 in fall 2009. At the same time, seniors in the Bachelor of Science engineering programs at UAF increased by 77 students from 120 in fall 2006 to 197 in fall 2009.

With high school enrollments in the State of Alaska starting to peak, before leveling off and likely declining, the enrollments at the two engineering schools will follow suit, especially when senior enrollments decrease as a result of students graduating within four, five, or six years of entering, rather than in seven or eight years. Currently, 40 percent of the Bachelor of Science engineering enrollment at UAA are seniors. At UAF, 35 percent of the Bachelor of Science engineering enrollment are seniors. As these students graduate and are not replaced by substantial increases in total program enrollments, the total baccalaureate engineering degree enrollments will begin to level off in the range of 600 or more students at each campus, despite recent surges in total Bachelor of Science enrollment in engineering. Program offerings, number of faculty, and facility needs should be geared to this reality, recognizing that becoming a senior does not necessarily mean that all required coursework is completed.

6. Graduate Programs: UAA and UAF should recognize that enrollments in their masters degree programs and Ph.D. programs may be at peak levels and in some cases have begun to slip. While graduate degrees awarded at UAA have been increasing, they may begin to decline as the result of the decline in graduate enrollment. Graduate degrees awarded at UAF have already reached a peak and are declining in number.

Unlike undergraduate engineering degree programs where enrollments have soared in the past few years, graduate engineering degree program enrollment at UAA has been in the range of 120 to 140 students annually, and at UAF in the range of 115 to 125 students annually.

These enrollments for full-time engineering graduate students at UAF are directly tied to level of financial support, which in turn is a result of the amount of incoming research income. At UAA, it is likely the part-time engineering graduate students are employed, so the UAA graduate enrollment is less tied to research funding. The expansion of UAF research, particularly in the area of energy research, may mark the beginning of a new growth in graduate students in engineering.

At UAA, the average number of years to complete a two-year engineering masters degree program is about four years. The same is true at UAF. Much of the recent increase in engineering graduate enrollments is the result of length of time to graduate. The engineering graduate courses at both campuses are offered daytime, evening, and online. At UAA, the engineering masters degree program in Project Management has accounted for approximately 50 percent of engineering graduate enrollments and nearly 60 percent of engineering graduate degrees awarded. At UAF, Petroleum Engineering accounts for approximately one-third of engineering masters degree enrollments and a similar percentage of engineering masters degrees awarded. Since engineering graduate admissions are competitive and controlled by the campus, the recent peaks in engineering enrollment and graduates may be an indication that the engineering graduate programs are reaching a steady state enrollment due to a leveling of extramural research funding. New opportunities for funding for engineering research would result in an upswing in engineering graduate students.

7. Two-Year Degree Programs: UAA and UAF should continue to work closely with their two-year community college programs in engineering-related disciplines and provide leadership to improve graduation rates and increase the number of graduates.

Two-year degree program students in engineering-related areas, as well as those who have started the engineering program and stopped out, constitute an important aspect of the engineering workforce in Alaska. According to data prepared for this report by the State of Alaska, Department of Labor and Workforce Development, approximately one-half of those who graduated in engineering from the University of Alaska in the past ten years and are currently employed in engineering in the State are employed in engineering support activities. Community college enrollment in engineering-related fields is burgeoning. Yet, the number of students who graduate these UA engineering-related programs is small in comparison to those who enter.

While the two-year engineering-related Associate of Science degree programs are long standing at UAA and relatively new at UAF, they have yet to be productive in terms of the number of students who graduate. On average, only 25 to 30 percent of these students graduate within three years of entering these two-year degree programs.

The enrollment in two-year engineering-related programs has been steady. Enrollments in the two Associate of Arts degree programs at the UAA Community and Technical College have stayed in the 80 to 90 student range annually, and have increased from 9 to 34 at UAF CTC in the past three years. The four-year program in Construction Management at the UAA CTC has grown from 27 to 99 students in the past three years.

The employment opportunities in Alaska for students with associate degrees in engineering-related fields is equal to the employment opportunities for engineering students who graduate with bachelors degrees. However, the number of students with associate degrees in engineering from UAA and UAF is not very large for the number of students enrolled in these programs.

8. Alaska High Schools: UAA and UAF should continue to work with high schools in their catchment area and throughout the State, particularly those schools with Academies of Engineering, to encourage and assist students who have an interest in entering engineering programs at the University.

Approximately 75 percent of the first-time freshmen entering engineering at UAA are from high schools in the Anchorage high school district. This is approximately 30 to 40 students annually from Anchorage high schools that graduate around 2,700 students per year. At UAF, with a historically broader catchment area statewide, approximately 25 percent of its first-time engineering freshmen are from high schools in the Fairbanks district. This also is 30 to 40 first-time freshmen engineering students annually from Fairbanks high schools that graduate about 800 students per year. Overall, over the past ten years, 93 percent of first-time engineering freshmen at UAA and 86 percent of UAF first-time engineering freshmen have been graduates of Alaska High Schools.

Of all spring 2000 public high school graduates in Alaska, 0.8 percent enrolled in engineering at UAA or UAF in fall 2000. By spring 2009, 1.8 percent of Alaska high school graduates enrolled in engineering at UA in fall 2009.

To overcome the effect of a potential decrease in students graduating from Alaska high schools, and a potentially similar decline in freshmen engineering enrollment, both UAA and UAF will need to continue to work with high schools, both in their catchment area and throughout the State, to increase the participation rate of high school graduates electing to enter the engineering programs at UAA and UAF.

Providing open houses to students interested in engineering, allowing qualified high school students to take courses at the University, and assisting engineering faculty to visit the high schools and work with students are all mechanisms for encouraging students considering engineering to take the required courses while in high school to be prepared for an engineering education at the university.

9. Engineering Education: UAA and UAF should examine each course in their engineering curriculum and how it is delivered. This goes beyond hands-on education and extends to what the individual can do for themselves in their education, both in person and online.

Another challenge to the engineering programs is that of engineering education itself. UAF is beginning to offer online engineering courses. More may be needed.

It has been said that engineering education may be one of the most thoroughly studied topics in the U.S. The core of the discussion about engineering education reform occurs as a result of many factors. As noted by UC Berkeley, changes will result from evolving technology, from the redefinition of traditional engineering disciplines and from the multi-disciplinary future of the sciences.[1] At the core of much of this change is the profound use of the computer and the ability for students to have access to vast information sources on the web. This has changed the way students think, learn, and visualize, as well as what they expect from life and from an education.[2]

10. Continuing Education of Engineers: UAA and UAF should become actively engaged in providing continuing education courses and services.

There is a need for and requirement of continuing education of engineers in Alaska. Thus far, the University of Alaska has had some involvement in the continuing education of engineers. The new requirement that professional licensed engineers achieve 24 hours of continuing education credit prior to their biennial re-licensing in Alaska will create more opportunities for UAA and UAF to be involved. The campus should increase their activities in this area.

William Wulf, when he was President of the National Academy of Engineering, stated "the half-life of engineering knowledge – the time in which half of what an engineer knows becomes obsolete – varies by field, but is estimated to be in the range of 2.5 to 7.5 years."[3] He states that the notion of lifelong learning has not been part of the engineering culture, either among individual engineers or in engineering schools. He notes that unlike business schools, where the best of the best have embraced executive training and where the best faculty vie to teach these courses, the best faculty at engineering schools studiously avoid involvement in continuing education.

11. Internships for Engineering Students: UAA and UAF should continue to provide more opportunities for internships and more involvement of the profession in engineering education.

It is likely that many of the students advance through an engineering curriculum at UAA or UAF without ever having been exposed to an engineering workplace or knowing exactly what an engineer actually does. Working closely with their employer and industry-based advisory boards, UAA and UAF should continue to seek their assistance in increasing internship opportunities.

A challenge occurs in finding internships for engineering students. One large corporation in Alaska that employs 2,500 and has approximately 500 engineers in their employ indicated that they would have three internships in 2010. This is a cost to their company but something they want to do. Another company of 70 employees indicated they support three engineering school interns annually as a mechanism to find students who later might become their employees and in the process offer to provide tuition support. There are likely other employers who might hire engineering interns, but it will take organized leadership by the campus to make this happen.

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1 "New Directions in the College of Engineering," UC Berkeley College of Engineering Facilities Master Plan, page 1, no date.

2 H. Baruh, Professor, Department of Mechanical and Aerospace Engineering, Rutgers University, "A Need for Change in Engineering Education," no date. http://coewww.rutgers.edu/~baruh/pdffiles/baruh2.pdf, accessed November 11, 2010

3 William A. Wulf, "The Urgency of Engineering Education Reform," *The Bent of Tau Beta Pi, Fall 1998,* page 22. http://www.tbp.org/pages/publications/bent/features/f98wulf.pdf, accessed November 11, 2010

12. Cost of an Engineering Education: UAA and UAF should review methods to find efficiencies and economies in engineering education, including perhaps the use of distance education, to provide education to more students without an increase in cost.

An additional challenge is the cost of an engineering education itself. Students who drop out are most likely a lost investment. Students who prolong their education because they are working or because they cannot achieve the necessary threshold course accomplishment, primarily calculus, also constitute an expense.

The recently enacted Alaska Performance Scholarship proposed by Governor Parnell and passed by the legislature will certainly be one catalyst for students to enroll in engineering. The pathway requirements for high school students requires and encourages students to take math and science courses, which are also the foundation requirements for engineering.

The Performance Scholarship will be a benefit to qualifying students seeking to enroll in the UAA and UAF engineering programs. It will reward them for their efforts to date, encourage them to be diligent in completing their degree work, and support them during an important period in their life.