Oregon University System

Proposal for a New Academic Program

Institution: Oregon State University
College/School: College of Engineering / School of Civil & Construction Engineering
Department/Program: BS in Architectural Engineering

1. Program Description

a. Proposed Classification of Instructional Programs (CIP) number

CIP Code #: 14.041

Title: Architectural Engineering

Definition: A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of materials, systems, and methods used to construct and equip buildings intended for human habitation or other purposes.

Source: US Department of Education, National Center for Educational Statistics, CIP 2010 ed.
https://nces.ed.gov/ipeds/cipcode/cipdetail.aspx?y=55&cipid=88204

b. Brief overview of the proposed program

The proposed BS in Architectural Engineering (ARE) degree program will provide students with breadth and depth in the engineering sciences of buildings and their systems: structural systems; heating, ventilation and air-conditioning (HVAC) systems; electrical and lighting systems; construction engineering and management. The program will emphasize integration across architectural engineering disciplines as well as with the existing civil engineering and construction engineering programs. The proposed ARE program will allow students to specialize in a chosen discipline while gaining the knowledge and skills to become leaders in the design and construction of green, energy efficient and more complex buildings.

There is only one accredited Architectural Engineering bachelor degree granting program on the West Coast, at the California Polytechnic State University, San Luis Obispo. Geographically, the next closest Architectural Engineering bachelor degree programs are in Wyoming and Colorado. An ARE program at Oregon State University would fill a void in the western US. The proposed program will also build upon the strong partnership between Civil & Construction Engineering (CCE) and Wood Science & Engineering (WSE), College of Forestry, to create an ARE program that is unique to Oregon State. The ARE program would also seek to strengthen links with the department of Architecture at the University of Oregon. As such the program is likely to attract students from other regions of the US as well as Oregon residents.

Summary: BS in Architectural Engineering Proposal

- CIP (Classification of Instructional Programs) #: **14.041**
- CPS #: **99017** https://secure.oregonstate.edu/ap/cps/proposals/view/99017
- Degree Type: **Bachelor of Science (BS)**
- Program Type: **Undergraduate**
- Academic Home: **College of Engineering, within the School of Civil & Construction Engineering**
- Location: **OSU-Corvallis**
- Undergraduate Specialization: **Structural Systems, Mechanical Systems, Electrical and Lighting Systems**
- Undergraduate Minor: **None**
- Course Designator: **ARE**
- Credit hours: **180**
- Pre- / Pro-Model: **Yes**
- Delivery Mode: **On-Campus**
- Enrollment Limitations: **None**
- Accreditation: **None**
- Proposed Effective Date: **Fall Term 2017 (Banner: 201701)**

c. Course of study – proposed curriculum, including course numbers, titles, and credit hours.

The proposed course of study totals 180 credit hours. Figure 1 provides a visual overview of the proposed curriculum. Figure 2 and Figure 3 focus on the Pre-Engineering and Professional Program portions, respectively. Courses are organized by categories. For example, the category of general civil / construction / architectural engineering courses is in the shaded band labeled "CCE/ARE". Table 1 provides a course summary with full course titles, course numbers and credit hours. Courses in the Pre-Engineering program that will be used to calculate GPA for entry into the Professional Program have been identified with this superscript ^{E}. Core courses in the Professional Program have also been identified and identified with this superscript ^{C}. Two courses that will serve as Writing Intensive Courses are marked with this symbol ^.

The program includes: 39 credit hours of baccalaureate core courses (identified as "Bacc Core" on Figure 1); 34 credits of mathematics, statistics, physics, and chemistry courses; 15 credits of general civil / construction / architectural engineering courses (CCE/ARE); 29 credit hours of structural engineering courses; 16 credit hours of construction engineering and management courses; 22 credit hours of courses focused on topics within

mechanical, electrical, plumbing and fire protection (MEPF); 11 credit hours of technical topics such as green building materials; 7 credit hours of capstone design courses; and 7 credit hours of technical electives.

The proposed curriculum was developed based on a survey of existing Architectural Engineering programs, a review of existing courses and curricula in Civil & Construction Engineering, and comparison to Accreditation Board for Engineering and Technology (ABET) accreditation requirements. The proposed course of study is consistent with 4-year Architectural Engineering programs at other universities and strongly leverages existing course offerings. 29 – 37 credit hours of new Architectural Engineering (ARE) courses are anticipated. New ARE courses are identified in bold font on Figure 1 and Figure 3. A few topics will be merged into an existing hydraulics course (CEM 311) to suit the needs of construction engineering management as well as architectural engineering students.

The ARE course designator has been approved by the Curriculum Council. Category II proposals have been created for all of the new, core Architectural Engineering courses and the Junior Seminar course:

ARE 301 ARE Junior Seminar

ARE 352 Design of Electrical and Illumination Systems for Buildings

ARE 353 Design of HVAC Systems for Buildings

ARE 418 Architectural Engineering Professional Practice (Capstone 1)

ARE 419 Architectural Engineering Design (Capstone 2)

ARE 451 Advanced Building Construction Methods

It is anticipated that Category II proposals for ARE technical electives (e.g., Energy Analysis, Controls, Fire Protection Design, or Other Elective(s)) will be created in a few years, after new Architectural Engineering faculty members have been hired, have taught a couple of the core courses, and have opportunity to develop technical elective course(s) in their specialty areas.

A major strength of the proposed ARE program is the opportunity for students to take electives in Wood Science & Engineering in addition to CE 484 Wood Design. WSE 592 Advanced Wood Design is listed as an approved elective in the proposed curriculum (Figure 3, Figure 1), but ARE students may seek approval to take any of the available courses. Possible courses include WSE 210 Renewable Material Technology & Utilization, WSE 321 Structure & Chemistry of Renewable Materials, WSE 322 Physical & Mechanical Properties of Renewable Materials, WSE 453 Global Trade in Renewable Materials, WSE 471 Renewable Materials in Building Construction, and WSE 473 Bioenergy & Environmental Impact.

An additional version of the proposed ARE curriculum has been provided for students who wish to participate in the Civil Engineering Cooperative Program (CECOP). Figure 4 shows a course planning form that accommodates the two paid industry internships and allows students to graduate on the typical CECOP timeframe.

Table 2 provides just a sampling of CECOP companies (out of 45 organizations that participated in 2017) that might hire ARE students, as well as additional companies in Portland and nearby cities that could be future members with interest in ARE students.

	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring
CCE/ ARE	MTH 251 (4)[E] Diff. Calculus	MTH 252 (4)[E] Integral Calculus	MTH 254 (4)[E] Vector Calc. I	MTH 306 (4)[E] Matrix/Pwr Series	MTH 256 (4)[E] Diff Equations	CEM263(3) Surveying	CCE 321 (4)[C] Materials		CE 372 (4)[C] Geotech I	Elective (4)[C]	ARE 418 (4) ^[C] Prof Practice/Cap1	ARE 419 (3) ^[C] ARE Design/Cap2
	CCE 101 (2) CCE Orientation	CCE 102 (3)[E] Prob Solving & Tech	PH 211 (4)[E] Gen. Physics/Calc.	PH 212 (4)[E] Gen. Physics/Calc.	CCE 201 (3)[E] Graphics & Design	CCE 203 (3) Virtual Des/Constr	ARE 301 (1) Seminar				CCE 422 (3)[C] Green Bldg Matls	Elective (4)[C]
	CH 201 (3)[E] Chemistry				ST 314 (3)[E] Intro Statistics							
Structures				ENGR 211 (3)[E] Statics	ENGR 213 (3)[E] Strength Materials	ENGR 212 (3)[E] Dynamics		CE 381 (4)[C] Structures I	CE 382 (4)[C] Structures II	CE 383 (4)[C] Steel Structures	CE 484 (4)[C] Wood Design	CE 481 (4)[C] Concrete I
Construction							CEM 442 (4)[C] Bldg Constr Mgmt		CEM 341 (4)[C] Estimating I	ARE 451 (4)[C] Adv Constr Mthds		
										CE 420 (4)[C] Engr Planning		
MEPF					ENGR 201 (3) Electrical Fund I		CEM 471 (4)[C] Electrical Facilities	ARE 352 (4)[C] Elec/Lighting Design				
								CEM 472 (3)[C] Mech Facilities	ARE 353(4)[C] HVAC Design			
								CEM 311 (4) Hydraulics[#]				
Bacc Core	Perspective (3) *(Cultural Diversity)*	PHL 205 (4) Ethics Persp. *(W.Culture)*	COMM 111/114 (3)[E] Speech Comm	ECON 201 (4) Micro-econ*(Social Proc&Inst)*		Perspective (3) Arch History *(Lit&Arts)*	Synthesis (3)				Diff, Power & Discrim (3)	Synthesis (3)
	WR 121 (3)[E] English Comp	HHS 231 (2) Lifetime Fitness	Biological Sci. (4)			WR327 (3) Technical Writing						
		PAC/HHS (1)										
Credits	15	14	15	15	16	15	16	15	16	16	14	14

Total credits 181

PRE-School Courses

[E]Required by College of Engineering for entry into the Professional Program (used to calculate GPA)

PRO-School Courses

[C]Core courses for the Professional Program; used to calculate GPA

Bold font indicates a new course for the Architectural Engineering program

^ Writing Intensive Course (WIC)

[#]CEM 311 Hydraulics will adapted to include a few additional topics; the course already includes a number of topics needed for ARE 353 HVAC Design as well as CE 372 Geotech I.

Pick 2 electives (8 total credits). Approved* electives:	
CE 482 (3)	Masonry Design
CE 427 (4)	Temp Structures
CE 480/580 (3)	Selected Topics in Structural Design
CE 373 (4)	Geotech II
WSE 592 (4)	Advanced Wood Design
CE 424 (4)	Contracts & Specs
CEM 443 (4)	Constr Project Mgmt
CEM 431 (4)	Obtaining Contracts (aka Reno class)
CE 594 (4)	Facility Design
ARE XXX (4)	**Energy Analysis**
ARE XXX (4)	**Controls**
ARE XXX (4)	**Fire Protection Design**
ARE XXX (4)	**Other elective(s)**
Free elective (1)	Free elective, if needed

*approval required for other courses

Figure 1: Overview of Proposed Architectural Engineering Curriculum

	Fall	Winter	Spring	Fall	Winter	Spring
CCE/ ARE	MTH 251 (4)^{E} Diff. Calculus	MTH 252 (4)^{E} Integral Calculus	MTH 254 (4)^{E} Vector Calc. I	MTH 306 (4)^{E} Matrix/Pwr Series	MTH 256 (4)^{E} Diff Equations	CEM263(3) Surveying
	CCE 101 (2) CCE Orientation	CCE 102 (3)^{E} Prob Solving & Tech	PH 211 (4)^{E} Gen. Physics/Calc.	PH 212 (4)^{E} Gen. Physics/Calc.	CCE 201 (3)^{E} Graphics & Design	CCE 203 (3) Virtual Des/Constr
	CH 201 (3)^{E} Chemistry				ST 314 (3)^{E} Intro Statistics	
Structures				ENGR 211 (3)^{E} Statics	ENGR 213 (3)^{E} Strength Materials	ENGR 212 (3)^{E} Dynamics
Construction						
MEPF					ENGR 201 (3) Electrical Fund I	
Bacc Core	Perspective (3) *(Cultural Diversity)*	PHL 205 (4) Ethics Persp. *(W.Culture)*	COMM 111/114 (3)^{E} Speech Comm	ECON 201 (4) Micro-econ*(Social Proc&Inst)*		Perspective (3) Arch History *(Lit&Arts)*
	WR 121 (3)^{E} English Comp	HHS 231 (2) Lifetime Fitness	Biological Sci. (4)			WR327 (3) Technical Writing
		PAC/HHS (1)				
Credits	15	14	15	15	16	15

Total credits 180

PRE-School Courses

^{E}Required by College of Engineering for entry into the Professional Program (used to calculate GPA)

Figure 2: Pre-Engineering Portion of the Proposed Architectural Engineering Curriculum

Fall	Winter	Spring
CCE 321 (4)[C] Materials		CE 372 (4)[C] Geotech I
ARE 301 (1) Seminar		
	CE 381 (4)[C] Structures I	CE 382 (4)[C] Structures II
CEM 442 (4)[C] Bldg Constr Mgmt		CEM 341 (4)[C] Estimating I
CEM 471 (4)[C] Electrical Facilities	**ARE 352 (4)[C] Elec/Lighting Design**	
	CEM 472 (3)[C] Mech Facilities	**ARE 353(4)[C] HVAC Design**
	CEM 311 (4) Hydraulics[#]	
Synthesis (3)		
16	15	16

Fall	Winter	Spring
Elective (3)[C]	**ARE 418 (4) ^[C] Prof Practice/Cap1**	**ARE 419 (3) ^[C] ARE Design/Cap2**
	CCE 422 (3)[C] Green Bldg Matls	**Elective (4)[C]**
CE 383 (4)[C] Steel Structures	CE 484 (4)[C] Wood Design	CE 481 (4)[C] Concrete I
ARE 451 (4)[C] Adv Constr Mthds		
CE 420 (4)[C] Engr Planning		
	Diff, Power & Discrim (3)	Synthesis (3)
15	14	14

PRO-School Courses

[C]Core courses for the Professional Program; used to calculate GPA

Bold font indicates a new course for the Architectural Engineering program

^ Writing Intensive Course (WIC)

[#]CEM 311 Hydraulics will adapted to include a few additional topics; the course already includes a number of topics needed for ARE 353 HVAC Design as well as CE 372 Geotech I.

Pick 2 electives (7 total credits). Approved* electives:	
CE 482 (3)	Masonry Design
CE 427 (4)	Temp Structures
CE 480/580 (3)	Selected Topics in Structural Design
CE 373 (4)	Geotech II
WSE 592 (4)	Advanced Wood Design
CE 424 (4)	Contracts & Specs
CEM 443 (4)	Constr Project Mgmt
CEM 431 (4)	Obtaining Contracts (aka Reno class)
CE 594 (4)	Facility Design
ARE XXX (4)	**Energy Analysis**
ARE XXX (4)	**Controls**
ARE XXX (4)	**Fire Protection Design**
ARE XXX (4)	**Other elective(s)**
Free elective (1)	Free elective, if needed

*approval required for other courses

Figure 3. Professional Program for the Proposed Architectural Engineering Curriculum

Table 1: Course Summary (part 1 of 2)

Architectural Engineering Degree	Credit Hours
Baccalaureate Core Classes	**39**
Speech Communications COMM 111/114[E]	3
English Composition WR 12[E]	3
Technical Writing WR327	3
Western Culture - Ethics PHL 205	4
Social Processes and Institutions - Introduction to Micro Economics ECON 201	4
Biological Science (1 course)	4
Lifetime Fitness for Health HHS 231	2
PAC/HHS (1 course)	1
Literature and the Arts - History of Western Architecture ART210	3
Cultural Diversity (1 course)	3
Synthesis (2 courses)	6
Difference, Power, and Discrimination (1 course)	3
Mathematics, Statistics, Physics, Chemistry	**34**
Differential Calculus MTH 251[E]	4
Integral Calculus MTH 252[E]	4
Vector Calculus I MTH 254[E]	4
Applied Differential Equations MTH 256[E]	4
Matrix and Power Series Methods MTH 306[E]	4
Introduction to Statistics for Engineers ST 314[E]	3
General Physics with Calculus PH 211[E]	4
General Physics with Calculus PH 212[E]	4
Chemistry for Engineering Majors CH 201[E]	3
General Civil/Construction/Architectural	**15**
CCE Orientation CCE 101	2
Problem Solving & Technology CCE 102[E]	3
Graphics & Design CCE 201[E]	3
Plane Surveying CEM263	3
Intro. to Virtual Design and Construction CCE 203	3
ARE Junior Seminar ARE 301	1
Structural Engineering	**29**
Statics ENGR 211[E]	3
Dynamics ENGR 212[E]	3
Strength of Materials ENGR 213[E]	3
Structural Theory I CE 381[C]	4
Structural Theory II CE 382[C]	4
Design of Steel Structures CE 383[C]	4
Reinforced Concrete I CE 481[C]	4
Wood Design CE 484[C]	4

[E]Required by College of Engineering for entry into the Professional Program (used to calculate GPA)

[C]Core courses for the Professional Program; used to calculate GPA

Table 1, cont'd: Course Summary (part 2 of 2)

Architectural Engineering Degree, cont'd.	Credit Hours
Construction Engineering and Management	**16**
Construction Estimating I CEM 341[C]	4
Engineering Planning CE 420[C]	4
Building Construction Management CEM 442[C]	4
Advanced Building Construction Methods ARE 451[C]	4
Mechanical, Electrical, Plumbing, Fire Protection	**22**
Electrical Fundamentals I ENGR 201	3
Electrical Facilities CEM 471[C]	4
Design of Electrical and Illumination Systems for Buildings ARE 352[C]	4
Hydraulics CEM 311	4
Mechanical Facilities CEM 472[C]	3
Design of HVAC Systems for Buildings ARE 353[C]	4
Other Technical Topics	**11**
Civil and Construction Engineering Materials CCE 321[C]	4
Geotechnical Engineering I CE 372[C]	4
Green Building Materials CCE 422[C]	3
Capstone Design	**7**
Architectural Engineering Professional Practice/Capstone ARE 418 ^[C]	4
Architectural Engineering Design/Capstone ARE 419^[C]	3
Technical Electives* (Choose 7 credit hours)	**7**
Masonry Design CE 482	3
Temporary Construction Structures CE 427	4
Selected Topics in Structural Design CE 480/580	3
Geotechnical Engineering II CE 373	4
Advanced Wood Design WSE 592	4
Contracts & Specifications CE 424	4
Project Management for Construction CEM 443	4
Obtaining Construction Contracts CEM 431	4
Transportation Facility Design CE 594	4
Energy Analysis ARE XXX	4
Controls ARE XXX	4
Fire Protection Design ARE XXX	4
Other elective(s) ARE XXX	4
Free elective, if needed	1

[C]Core courses for the Professional Program; used to calculate GPA

^ Writing Intensive Course (WIC)

*approval required for courses other than those listed

ARCHITECTURAL ENGINEERING PROFESSIONAL PROGRAM
with CECOP

Note: Course schedule and offerings subject to change. Check OSU Online Schedule of Classes when registering.

	JUNIOR YEAR				SENIOR YEAR 1			
Cr.	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Cr.
1	# Synthesis - Sci., Tech & Soc. F,W,S	CEM 311 Hydraulics W,S	First	Internship	CEM 442 Bldg Const Mgmt	ARE 418^ Prof Practice/ Capstone 1	ARE 419^ ARE Design/ Capstone 2	1
2								2
3								3
4	CE 381 Structural Theory I F, W						CE 481 Reinforced Concrete I F,S	4
5		CE 382 Structural Theory II W,S			CE 420 Engineering Planning F,W	CE 383 Design of Steel Structures F,W		5
6								6
7								7
8	CEM 471 Electrical Facilities						ARE 353 HVAC Design	8
9		ARE 352 Elec/Lighting Design			ARE 451 Adv Constr Methods	# Synthesis - Contemp. Global Iss. F,W,S		9
10								10
11								11
12	CCE 321 Civil & Construction Engineering Materials F,S					CE 372 Geotechnical Engineering I W,S	CEM 341 Construction Estimating I	12
13		CEM 472 Mechanical Facilities			ARE Elective			13
14								14
15								15
16	ENGR 407 CECOP Sem				ARE 301 Seminar			16

^	Writing Intensive Course
#	Courses may be taken for S/U grade.

F, W, S = Term(s) in which course is offered.
If a course has no terms listed below it (e.g. F,W,S), it is only taught in the term it appears in.
Technical Electives are CoE upper division (300-600 level) courses not otherwise required in the major.
ENGR 407 may count for 1 of the 11 required technical elective credits.
Pre-Engineering program is the same as for non-CECOP plan
Total credits required for BS ARE = 180 credit hours (average load = 15 credits per term)

	SENIOR YEAR 2		
Summer	Fall	Winter	Cr.
Second	Internship	CE 484 Wood Design	1
			2
			3
			4
		# Diff, Power & Discrim F,W,S	5
			6
			7
		ARE Elective	8
			9
			10
			11
		CCE 422 Green Building Materials	12
			13
			14
			15
			16

Figure 4: Proposed ARE Planning Form for Civil Engineering Cooperative Program (CECOP)

Table 2: Sampling of Current CECOP Companies and Possible Future CECOP Members with Interest in ARE Students

Current/Possible Member	Company Name	Location	Comments
Current	WHPacific, Inc.	Portland, OR	Facilities division employs structural, mechanical and electrical engineers, architects, and other professionals
Current	Tetra Tech, Inc.	Portland, OR	Design and Engineering division includes architecture, structural, mechanical, and electrical engineering.
Current	Cardno	Portland, OR	Design division includes structural, mechanical, and electrical engineering.
Current	VLMK Engineering + Design	Portland, OR	Provides consulting engineering services to architects as well as owner/developers and contractors
Current	AECOM	Portland, OR	"Integrated solutions" include architectural and building engineering services (e.g., structural, mechanical, electrical and plumbing)
Current	HDR, Inc.	Currently, Portland, OR; add offices in other cities	Offers "integration of engineering systems to support and enhance architectural designs with energy-efficient and cost-effective building systems"
Current	Cellar Ridge Construction	McMinnville,OR	Green building construction utilizing sustainable building technologies and design practices
Current	Emerio Design	Beaverton,OR	Employs architects and engineers for residential construction
Possible	AEI Consultants	Portland, OR	Services include green building assessments, e.g., building energy audits
Possible	Mackenzie	Portland, OR	Services including architecture and interior design, structural engineering
Possible	Livermore Architecture & Engineering, Inc.	Portland, OR	Integrates architectural design with structural engineering for commercial and industrial projects
Possible	Jackola Engineering & Architecture, PC	Vancouver, WA	Integrated architecture and engineering services
Possible	I-ENG-A, Forensic division of ICHTHYS Engineering PLLC	Vancouver, WA	Services include forensic engineering (investigation) and design of HVAC, plumbing, and fire sprinkler systems
Possible	Fluent Engineering, Inc.	Salem, OR	Lighting, commissioning, facilities, building systems
Possible	CIDA	Portland, OR	Architecture, engineering, planning and interiors
Possible	Symons Engineering Consultants, Inc.	Portland, OR	Services include architectural engineering and structural engineering consultation
Possible	OTAK	Portland, OR	Multidisciplinary design firm with engineers, architects, urban planners; sustainable design

d. Manner in which the program will be delivered, including program location (if offered outside of the main campus), course scheduling, and the use of technology (for both on-campus and off-campus delivery).

The proposed Architectural Engineering (ARE) program will be offered at the OSU-Corvallis campus. The ARE program will join Civil Engineering (CE) and Construction Engineering Management (CEM) in what is currently the School of Civil & Construction Engineering (CCE), and will utilize all existing technologies for on-campus instruction. Course scheduling will be administered in the same manner as for CE and CEM courses. While there is no immediate plan for Ecampus instruction during the first years of the program, the hope is that, over time, courses will be developed for on-line delivery to specifically encourage potential students from the Cascades Campus, University of Oregon, the community college network, the Portland metro area and throughout the rest of the state to work towards a degree in this program. This will also provide access to education for working professionals seeking to obtain additional qualifications and training.

e. Ways in which the program will seek to assure quality, access, and diversity.

CCE's Undergraduate Curriculum Committee, including faculty associated with the ARE program, will seek to assure quality through a regular review process, including collaboration with the standing CCE Industrial Advisory Board (IAB). A formal review process will follow the OSU Undergraduate Academic Program Review (UAPR) guidelines for review of newly formed programs and for regular reviews every 10 years. Informal reviews of the ARE program will be conducted within the school annually as currently done with the CE and CEM degree programs currently offered. While the School of CCE and the IAB currently have members that have an expertise in buildings, CCE will seek to recruit 3 new members to the existing CCE IAB, which provides review of strategic plans and curricula. The CCE IAB currently meets twice each year to discuss activities in the school and to review the program. The degree program has been discussed with the CCE IAB, and they have expressed enthusiastic support for the ARE program.

The ABET accreditation process includes the evaluation and improvement of student learning outcomes. The ARE program will utilize the ABET outcomes (1-7) that are currently under public review. This choice was made based on the high likelihood that these outcomes will be adopted permanently by ABET, and the desire to not have to re-align courses and curriculum twice. Required ARE courses will report the degree to which they met the course outcomes they are associated with on an annual basis. Continuous improvement of these outcomes will also occur over time, through an iterative process of measurement, reflection, and improvement. This process will lead to improvement in student learning over time. Access and diversity are a more explicit component of the new ABET criteria, as compared to previous versions. ABET Student Learning Outcome 7 states "An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment." Through the evaluation and improvement of this outcome we will be able to understand and improve how some of the ARE course curricula affect a

collaborative and inclusive environment. The fostering of an inclusive environment is critical to promoting access and diversity for all students. This process is very similar to that followed by Civil Engineering (CE).

Access to the ARE program will be in keeping with the OSU policy of increasing access to innovation through non-traditional delivery modes and the promotion of lifelong learning. CCE will build on its strong programs with the community colleges to develop a fact sheet for students at community colleges to describe how community college offerings throughout Oregon can be transferred to OSU thus making it possible for many students to start their degree at their current location before moving into this program.

Goals 2 and 3 of the OSU Campus Diversity Action Plan and the College of Engineering (COE) strategic plan on including inclusive and collaborative communities will be central to the proposed ARE program. Specifically, faculty will work on an "effective recruitment pipeline" to accommodate changing demographics, with increasing numbers of women and underrepresented minorities. Faculty will also strive to provide a climate that ensures retention and graduation rates of underrepresented students and women that are on par with those of majority populations in engineering. Mike Brayson, Mt. Hood Community College Advisor of Architectural Engineering Technology (AET), notes in his letter of support that "In reviewing the proposal there was some mention about how the Architectural Engineering program could potentially attract more students with ethnic and gender diversity. I would like mention that yes, this matches the experience we have had with the AET program at MHCC. This is anecdotal, but I would estimate that the female and minority populations that have graduated with AET to be about double of what we have experienced with the other ET offerings."

Architectural Engineering attracts greater percentages of female students than many other engineering disciplines, as noted above and as evidenced by 2015 enrollment data from the Pennsylvania State University (PSU) (Table 3). Architectural Engineering has more than twice the female enrollment of Civil Engineering, and, at 35%, has among the highest percentages of female students in the College of Engineering. Similar trends were noted for Fall 2014 enrollments. Ellen Momsen, Director of Women & Minorities in Engineering at OSU, notes that "at UT Austin, Architectural Engineering has an even higher percentage of women than BioMedical Engineering." (See e-mail correspondence in supporting documents.) Estes and Brady[1] stated in a 2011 article that "architectural engineering programs graduate on average 30% women which is far higher that the percentages of women in other engineering programs … The most noteworthy data point is the University of Nebraska where the [architectural engineering] enrollment of women is at least triple every other category." Estes and Brady also asked female architectural engineering students at one program why they chose architectural engineering. Two-thirds of the survey respondents indicated a strength in math and interest in art / architecture. Almost two-thirds of respondents noted that they had considered majoring in architecture. Hosey[2] refers to studies that show that "statistically women are much more

[1] Estes, A.C. and Brady, P. (2011) "Participation of Women in Architectural Engineering: What Causes It?" Architectural Engineering Conference (AEI) 2011, March 30-April 2, 2011, Oakland, CA. http://dx.doi.org/10.1061/41168(399)11

[2] Hosey, L. (2013) "Women in (Green) Architecture Now," The Huffington Post, June 20, 2013, Accessed 4/3/17. http://www.huffingtonpost.com/lance-hosey/women-in-green-architecture-now_b_3472117.html

likely than men to support environmental causes", and that women on average have a "considerably lower" carbon footprint than men in the U.S., and discusses past and future female leaders in sustainable building design. Informational print, e-mail and website materials for the proposed ARE program will have targeted distribution to female students; faculty will utilize their associations with the Society of Women Engineers, Women in Engineering programs, Phi Sigma Rho, and other organizations to reach this traditionally underrepresented group.

Table 3: Enrollment in PSU Engineering Programs

PENNSYLVANIA STATE UNIVERSITY (PSU) ENGINEERING ENROLLMENT FALL 2015					
Campus	**Academic Program**	**Total**	**Percent Female**	**Percent UR**	**Percent International**
University Park	Aerospace Engineering	236	10.6%	9.3%	6.4%
	Architectural Engineering	338	35.0%	4.1%	12.1%
	Biological Engineering	105	39.0%	11.4%	6.7%
	Biomedical Engineering[2]	178	39.9%	6.7%	7.3%
	Chemical Engineering	440	25.2%	6.8%	16.1%
	Civil Engineering	369	14.9%	6.0%	9.2%
	Computer Engineering	219	7.8%	12.3%	13.2%
	Computer Science	318	11.0%	7.2%	14.5%
	Electrical Engineering	533	8.8%	9.4%	16.7%
	Engineering Science	82	15.9%	11.0%	13.4%
	General Engineering[3]	44	11.4%	13.6%	0.0%
	Industrial Engineering	374	30.7%	10.2%	29.4%
	Mechanical Engineering	870	13.7%	6.2%	13.1%
	Nuclear Engineering	166	12.1%	7.8%	7.8%
	Pre-engineering	3,618	23.7%	10.1%	17.2%
	University Park Total	**7,846**			
	University Park Average		**20.9%**	**8.8%**	**15.5%**
Other Locations		2,915			
Total		**10,761**			

UR – underrepresented http://www.engr.psu.edu/facts/undergrad-enrollment.aspx

It would be the goal of the COE and CCE to continue to encourage participation of underrepresented groups. The program will utilize existing avenues at OSU, such as the Louis Stokes Alliance for Minority Participation (LSAMP) program, funded by the National Science Foundation Example activities: visiting local high schools, supporting an advisor at Linn Benton Community College one day per week and at Chemeketa Community College once a month, hosting a "Day at OSU" each term for underrepresented minority (URM) students who are currently in community college,

hosting a summer bridge program for incoming first year URM students (about 60 students each year) and a Leadership Program for first year and transfer students (about 200 students). In addition, there is a Pacific Northwest LSAMP Conference, which was held at OSU this year (March 2017) with over 250 URM STEM students from community colleges and universities in the Pacific Northwest attending.

As summarized by Ellen Momsen, "We can get the word out to prospective students in a wide variety of ways! To reach prospective students, we have a COE Ambassador Program: current COE students visit high schools throughout the state, and lead tours of the College each day at 2 pm. We have over 5000 students come on school field trips: they come to visit the wave lab and also get to hear a presentation on all our engineering majors. We participate in the Oregon Science Teachers Association conference each year. We also partner with PreCollege Programs which offers a wide variety of K12 engineering camps and activities." Additional details about diversity groups and efforts on campus can be found in the supporting documents.

f. Anticipated Fall term headcount and FTE enrollment over each of the next five years.

Enrollment data was obtained for a number of Architectural Engineering programs, including University of Texas, University of Nebraska, University of Colorado, and University of Kansas. Architectural Engineering is in the same department with Civil and Environmental Engineering at U. Texas, U. Colorado, and U. Kansas. U. Nebraska has a School of Architectural Engineering and Construction. These four programs had rather similar enrollments and numbers of B.S. degrees granted in a given year. In Fall 2015, the total enrollments in Architectural Engineering were 166, 168, 143, and 112, for Texas, Nebraska, Colorado and Kansas, respectively. B.S. degrees conferred in 2015 were 42, 26, 40, and 37. Historical data provided for U. Nebraska shows degrees conferred ranging from 18 to 47 over the past 10 years. Data for U. Kansas shows a range of 26 to 37 graduates over the past four years.

http://www.engr.utexas.edu/about/facts/programdata

http://engineering.unl.edu/durhamschool/durham-ae-abet-accreditation/#tab5

http://www.colorado.edu/engineering/about/facts

https://engr.ku.edu/enrollment-and-graduation-data

Based on this data and a projected timeframe for recruiting efforts, an estimate of FTE enrollment over the next five years has been made (Table 4).

g. Expected degrees/certificates produced over the next five years.

Please see Table 4 for an estimate of the expected B.S. degrees in Architectural Engineering over the next five years.

Table 4: ARE Enrollment Estimate*

Year	1 2017-18	2 2018-19	3 2019-20	4 2020-21	5 2021-22
1st cohort	20#	20#	10	10	
2nd cohort		20#	20	20	20
3rd cohort			30	30	30
4th cohort				40	40
5th cohort					40
Total FTE	**20**	**40**	**60**	**100**	**130**
Total Graduates	0	10	0	10	20

*Includes students who have not officially been admitted to the Professional Program but are following the Pre-Engineering Program for Architectural Engineering;

#includes students already admitted to the Civil Engineering Professional Program for 2017-18 who decide to change to Architectural Engineering.

h. Characteristics of students to be served (resident/nonresident/international; traditional/nontraditional; full-time/part-time; etc.)

The ARE program will serve primarily full-time students of traditional age to begin; however it is anticipated that non-traditional students will become involved if on-line offerings are provided. For the first two to three years, the expectation is that the distribution of resident / non-resident / international students will be very similar to that of the current undergraduate CCE population, however additional students may be drawn to this program due to the lack of programs of this type on the west coast. It is anticipated that the program would consist of approximately 60% Oregon residents, 30% out-of-state students, and 10% international students. By the third or fourth year, this unique ARE program is expected to attract a larger population of out-of-state students from the region; the proposed program will be one of only two ARE programs west of the Rocky Mountains.

i. Adequacy and quality of faculty delivering the program.

Over a period of several years there has been increasing involvement of a number of OSU engineering faculty in applications that could fall into the areas of architectural engineering. A large number of faculty are now working in interdisciplinary teams on construction visualization (with two new hires in 2016), building air quality, new and green materials (with new hires in 2014/2015), and building energy efficiency. In Fall 2016, a faculty line was opened for a faculty member specifically dealing with architectural engineering building systems, and a faculty search was conducted. With over 36 faculty members in CCE, as well as several instructors, the school is well positioned to strategically add a few new faculty while using significant current faculty expertise to offer this degree. The new faculty would be specifically hired to bring new

information on building systems, building system commissioning, and other specialty topics.

j. Faculty resources – full-time, part-time, adjunct.

Consistent with other programs in Civil & Construction Engineering, participating faculty will be primarily tenure-track/tenured appointments with significant assignments in research and scholarship, as well as professional faculty that can provide some practical field coursework. The program will also seek to work closely with Wood Science & Engineering at OSU and the University of Oregon's Architecture program.

k. Other staff.

The ARE program will be administered in the School of Civil & Construction Engineering using existing support staff.

l. Facilities, library, and other resources.

Resources, such as classroom space and computer laboratories, for the ARE Program are already in place in the School of Civil & Construction Engineering. Two-three new faculty offices will be needed, and this has been discussed with the College of Engineering. In addition, with a few new course offerings, a laboratory teaching space may be needed as well as additional sections for common classes.

Resources available at OSU Libraries were informally reviewed with respect to ARE course topics (i.e., the new courses for the ARE curriculum). OSU Libraries currently has over 1000 references for heating, ventilation, and air-conditioning (HVAC), 30 additional resources focused on HVAC controls and systems. The catalog offers several journals including the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook. OSU Libraries house over 1000 references for building energy efficiency, modeling and analysis. There are over 100 references for electrical and lighting systems for buildings, including some resources on integrated mechanical/electrical design and building systems engineering. OSU has over 500 references for fire protection, with dozens focused on focused on fire protection for buildings. There are thousands of references for architecture, with over 1000 on modern architecture alone.

A formal Library Evaluation was conducted, with comparisons to peer institutions, with the conclusion that additional library resources are needed to support this proposal. Less than $2500 a year for the next 3 years is estimated primarily to subscribe to the following journals: *Materials and Structures* and *Structural Control and Health Monitoring*. It should be noted that these journals may be specific to the research conducted by faculty at some of the peer institutions and are not directly related to the new disciplines (e.g., HVAC controls and systems, building energy efficiency) that will be added to CCE with the creation of the ARE program. However, new ARE faculty are likely to bring other unique research areas to OSU, and so the recommendation from the Library Evaluation has been included in the proposed budget.

m. Anticipated start date.

Initial, anticipated start date of September 15, 2017 will understandably be later than proposed due to the extensive review process.

2. Relationship to Mission and Goals

a. Manner in which the proposed program supports the institution's mission and goals for access; student learning; research, and/or scholarly work; and service.

The proposed B.S. in Architectural Engineering (ARE) will support OSU's mission and goals for education, research and service by providing an integrated, multidisciplinary program in the engineering sciences of buildings and their systems. The ARE program will both leverage and strengthen the existing curricula and research in Civil & Construction Engineering (CCE). New ARE courses and faculty will broaden the school's impact in the signature area of advancing the science of sustainable earth ecosystems, to now encompass the ecological footprint associated with building energy efficiency and sustainable design and construction practices. Students already interested in CCE will have an additional option and competitive advantage in an ARE program that will provide them with knowledge and skills to become leaders in sustainable building design and construction. The diverse nature of Architectural Engineering and its disciplines will attract new students to the school and serve the changing demographic in Oregon and the region. Engagement and collaboration with an industrial advisory board will ensure that the ARE program is serving the needs of the industry.

b. Connection of the proposed program to the institution's strategic priorities and signature areas of focus.

The proposed ARE program supports OSU's strategic goals of demonstrating leadership in research, scholarship and creativity, and of strengthening impact and reach throughout Oregon and beyond. The ARE program also has its own goals for recruiting female students and other underrepresented groups, thus implementing one strategy of OSU's goal to provide a transformative educational experience for all learners.

The ARE program will complement existing research programs and scholarly activities in Civil and Construction Engineering, while providing additional opportunities for innovation in the engineering sciences for buildings. These opportunities include advances in the signature area of sustainable earth ecosystems, specifically sustainable building design and construction. Advances may have emphasis in building energy efficiency and a building's ecological footprint from groundbreaking to possible demolition, or design for deconstruction and reuse. The program will also leverage partnerships with Wood Science & Engineering (WSE), in OSU's College of Forestry, as well as Architecture at the University of Oregon, and industry stakeholders. As noted by Eric Hansen, Professor and Interim Department Head (WSE), CCE and WSE "are already strongly linked through students who pursue dual majors in Wood Science and Civil Engineering, as well as through the TallWood Design Institute. The TallWood Design Institute relies on collaboration with the University of Oregon School of

Architecture and Allied Arts, as well, for experience in sustainable design and energy efficiency. This collaboration can only be strengthened with the new Architectural Engineering program."

The proposed program would be one of only two ARE schools in the western US. Furthermore, the partnerships with WSE and U. of Oregon Architecture, and the Tall Wood Design Institute collaboration, create an ARE program that is unique to Oregon State University. As such, OSU's ARE program will not only be a place to go to study Architectural Engineering, but it will be *the* program for engineering of sustainable wood-frame buildings. In this manner, the proposed ARE program is expected to enhance OSU's impact nationwide.

c. Manner in which the proposed program contributes to Oregon University System goals for access; quality learning; knowledge creation and innovation; and economic and cultural support of Oregon and its communities.

The proposed B.S. in Architectural Engineering (ARE) will support the OUS system goals by providing an integrated, multidisciplinary program in the engineering sciences of buildings and their systems. New ARE courses and faculty will broaden the school's impact in the signature area of advancing the science of sustainable earth ecosystems, to now encompass the ecological footprint associated with building energy efficiency and sustainable design and construction practices. The diverse nature of Architectural Engineering and its disciplines will attract new students to the school and serve the changing demographic in Oregon and the region. It is anticipated that the program would be of particular interest for underrepresented students as well as first generation college students.

d. Manner in which the program meets broad statewide needs and enhances the state's capacity to respond effectively to social, economic, and environmental challenges and opportunities.

The program will emphasize integration across architectural engineering disciplines as well as with the existing civil engineering and construction engineering programs. The proposed ARE program will allow students to specialize in a chosen discipline while gaining the knowledge and skills to become leaders in the design and construction of green, energy efficient and more complex buildings. The construction industry is a leading job provider for all Oregonians of different economic classes. Providing industry qualified and Oregon trained human resources is critical for the continued growth of this industry.

3. Accreditation

a. Accrediting body or professional society that has established standards in the area in which the program lies, if applicable.

The Accreditation Board for Engineering and Technology (ABET) is the accrediting body with established standards for programs in Architectural Engineering. The lead society is the American Society of Civil Engineers (ASCE), and the cooperating society is the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). The proposed curriculum was developed following the ABET program criteria, which outlines requirements for subject areas such as mathematics, basic sciences, engineering sciences and engineering design specific to the field of study.

A related topic is licensure. A graduate from an accredited engineering program can pursue licensure as a Professional Engineer (PE) in his or her discipline (e.g., PE- Civil: Structural, PE-Mechanical: HVAC and Refrigeration). One may also obtain a PE in Architectural Engineering. The Oregon State Board of Examiners for Engineering and Land Surveying (OSBEELS) does not currently offer the exam for the PE-Architectural. However, since June 2015, OSBEELS does recognize the PE-Architectural (Building Systems), so an engineer who has passed the exam in another state (e.g., Washington) would be considered for licensure in Oregon as a PE especially qualified in Building Systems. Currently, there are only 7 professional engineers especially qualified in Building Systems in Oregon.

b. Ability of the program to meet professional accreditation standards. If the program does not or cannot meet those standards, the proposal should identify the area(s) in which it is deficient and indicate steps needed to qualify the program for accreditation and date by which it would be expected to be fully accredited.

As stated above, the proposed curriculum was developed following the ABET program criteria for Architectural Engineering and is expected to meet all professional accreditation standards.

c. If the proposed program is a graduate program in which the institution offers an undergraduate program, proposal should identify whether or not the undergraduate program is accredited and, if not, what would be required to qualify it for accreditation.

Not Applicable.

d. If accreditation is a goal, the proposal should identify the steps being taken to achieve accreditation. If the program is not seeking accreditation, the proposal should indicate why it is not.

ABET has a 5-step, 18-month accreditation process that includes a self-study report and on-site visit. Programs must first satisfy eligibility requirements, including having at least one graduate. The first graduates of the full ARE program (i.e., the Pre-Engineering and the Professional Program) are expected in Year 4; therefore, the plan is to start the 5-step process at the end of Year 4. However, eligibility requirements and the entire 5-step accreditation process will be reviewed in Year 1, and an internal, preliminary self-study report will be drafted starting Year 2 to prepare for the formal accreditation process.

4. Need

a. Evidence of market demand.

The demand for architectural engineers can be difficult to assess, because most graduates self-identify by the disciplines (e.g., structural engineering, building mechanical systems) which are often categorized with civil engineering (structural) or mechanical engineering. However, by some sources, the projected job growth for architectural engineers could be as high as 20% for the period between 2012 and 2022[3].

Meanwhile, there is demand for architectural engineers in Oregon. Table 2 with some current and possible future CECOP companies in Portland and nearby cities shows just a sampling of firms that do integrated architecture and engineering work, focus on sustainable design of buildings, and/or have engineers in architectural engineering disciplines such as building mechanical and electrical systems. CECOP company Cellar Ridge Construction uses green building science to produce energy efficient and sustainable residential and commercial buildings, including tasting rooms and production facilities for wineries. Cellar Ridge does not accept the building code minimums, which can result in poor building performance (e.g., moisture/mold problems), but uses engineering principles (e.g., heat transfer) for buildings with high standards for beauty, durability, water conservation, energy efficiency, and indoor air quality. Founder John Mead notes that it has been difficult to find people with the right background for this work, and that his strategy thus far has been to hire people with good engineering skills and then to provide, in house, the necessary training. Mead states that there is "absolutely a need" for engineers with the type of background to be provided through the proposed Architectural Engineering degree program. Mead added that the green building industry is "booming." He started Cellar Ridge Construction 11 years ago because he saw the potential; his company has seen a 20% revenue growth rate and expects this to continue. Additional details are summarized in e-mail correspondence with Mead in the supporting documents.

Oscar Zuniga, a Mechanical, Electrical, & Fire Protection Principal at Marquess & Associates, Inc. and an OSBEELS Board Member, shares Mead's perspective. In an e-mail to COE Dean Scott Ashford, Zuniga provided a "statement of interest in the Building Systems program that is in development at OSU and … an offer of anything I

[3] http://study.com/articles/Architectural_Engineers_Job_Description_and_Requirements_for_a_Career_in_ Architectural_Engineering.html

can do personally to encourage development of the program because there are very, very few programs that are tailored to this specific application of engineering. For example, our consulting company has been actively searching for an electrical engineer for several years, with no success. We get applications from software engineers, power generation and transmission engineers, electronics engineers, and the like but none of them knows anything about building systems. Kudos to you and the University for recognizing this need and stepping up to fill it!" A copy of Zuniga's e-mail is provided in the supporting documents.

As previously mentioned there is only one accredited ARE program currently on the west coast. Engineering firms in Portland currently hire from that one west coast ARE program, because of their graduates' knowledge of building systems in addition to the structural engineering specialty. When asked about architectural engineers at his firm and his thoughts on the proposed Architectural Engineering Program, Josh Richards, Principal at KPFF's Portland office, stated, "Regarding the Arch E program, our engineers are generally focused primarily on structural and civil engineering and we do not have any other disciplines in our Portland office. However, I do believe that general knowledge of these systems is important and beneficial; Cal Poly has a similar program and we've hired many engineers from that institution over the years." Meanwhile, existing ARE programs are all heavily subscribed and many have program capacity limits. This proposed program has received overwhelming support from the school's industrial advisory board (IAB).

Mt. Hood Community College has a 2-year architectural engineering technology program that offers some courses such as Sustainable Energy Modeling and Structural Design. The program is not accredited, is limited in course offerings, and does not have the breadth and depth offered by the country's 4 or 5 year ARE programs. Mt. Hood's graduates work as architectural engineering technicians who assist engineers, architects and other industry professionals. Mike Brayson, MHCC Advisor of Architectural Engineering Technology, notes in his letter of support for the proposed degree program: "Technical tools and modeling software used in the AEC market has evolved over the last decade ..." and "Oregon and the building construction industry needs a program like this. The application of these emerging technologies, in both scope and depth, goes well beyond what we can cover with a two year community college experience."

Oregon State University has also conducted a case study of the university's future opportunities in the Portland region through 2025[4]. The case study purpose was to provide an assessment of Portland's current and emerging economic strategies, industry needs, workforce needs, learner needs and community needs. The results are serving to advise Oregon State University's development of future services for the Portland region. Part of the case study was a survey of prospective adult learners in Portland on areas such as Business Administration, Health Professions, Liberal Arts and Humanities, Natural Resources and Engineering. Within Engineering, Architectural Engineering was one of less than a dozen engineering disciplines that scored "high" for "economic opportunity and demand" and one of only three engineering disciplines to score "high" for "learner demand."

[4] "Oregon State University in Portland: A case study," Oregon State University, Office of the Provost, March 19, 2017.

Data from the Architectural Engineering Institute (AEI), a discipline-specific institute of the American Society of Civil Engineers (ASCE), further demonstrates the potential for the proposed degree program to fill a void in the Pacific Northwest. Catherine Tehan, Director of the Architectural Engineering Institute, reports that there are currently only 6 AEI members in Oregon and just 13 AEI members in Washington State. Compared to 359 AEI members in California, 109 AEI members in Texas, and 353 members in Pennsylvania, the low numbers in Oregon and Washington highlight both a need in the region and the opportunity for OSU to help to address this need.

b. If the program's location is shared with another similar OUS program, proposal should provide externally validated evidence of need (e.g., surveys, focus groups, documented requests, occupational/employment statistics and forecasts).

The proposed ARE program will be unique at OSU. The program will leverage existing courses and complement the Civil & Construction Engineering curricula with new courses in engineering of heating, ventilation and air-conditioning systems, electrical and lighting systems.

c. Manner in which the program would serve the need for improved educational attainment in the region and state.

The ARE program will have breadth and depth in the engineering sciences of buildings and their systems. New courses will provide the missing pieces for a comprehensive, integrated program of study in architectural engineering.

Currently education in Oregon is below the state's stated goal of 40-40-20 (40% having bachelors or higher, 40% having an associate's degree, and 20% having a high school diploma). This program will offer opportunities to young people who want to pursue a ARE career who either currently do not have this option or must leave Central Oregon to get a 4-year degree.

d. Manner in which the program would address the civic and cultural demands of citizenship.

The graduates of the proposed ARE program will be prepared to become professional engineers in a specialization of their choosing, and to take on leadership roles in the sustainable design and construction of buildings. With their breadth and depth of knowledge of the engineering sciences of buildings, our ARE graduates will advance the state of the art in building energy efficiency and other sustainable engineering practices.

5. Outcomes and Quality Assessment

a. Expected learning outcomes of the program.

Educational objectives for the program were determined from a survey of peer institutions; the objectives for University of Texas at Austin[5] fit well with the goals of the proposed ARE program and therefore have been adopted. Student learning outcomes are as defined by ABET (accreditation requirements).

Educational Objectives

Graduates of the Architectural Engineering program should solve architectural engineering problems within a greater societal context by doing the following:

1. Exhibit character and decision-making skills embodying professionalism and ethical behavior.
2. Apply knowledge, strong reasoning, and quantitative skills to design and implement creative and sustainable solutions.
3. Engage in life-long learning to meet evolving engineering challenges facing society.
4. Exhibit strong communication, critical thinking, interpersonal, and management skills as leaders and contributors in the architectural engineering profession.

Student Learning Outcomes (ABET)

Graduates of the Architectural Engineering program should attain the following outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to communicate effectively with a range of audiences.
5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. An ability to recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.

[5] http://www.caee.utexas.edu/ about/8-about/39-areobjectives

7. An ability to function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

b. Methods by which the learning outcomes will be assessed and used to improve curriculum and instruction.

Learning outcomes will be assessed and used to improve instruction in the same manner as courses in Civil & Construction Engineering (CCE). Each term a course is offered, the instructor creates a course summary, or evaluation, that maps the relevant ABET student learning outcomes to the course assessments (e.g., homework assignments, lab assignments, projects, quizzes, exams). Instructors track student scores on those assessments to evaluate how well the course achieved specific learning outcomes. This evaluation is also completed for any specific course learning outcomes defined by the instructor.

Course improvements implemented in that term are also summarized and mapped to the learning outcomes. Improvements needed for the next course offering are noted and mapped to the learning outcomes, as well. In this manner, instructors evaluate their courses with respect to learning outcomes and use results of those evaluations to improve course instruction. Table 5 shows an older template for this course summary.

Starting with the preliminary self-study in Year 2 (see Section 3d), the Undergraduate Curriculum Committee will review summaries for selected courses with respect to the Educational Objectives for the ARE program. Student outcomes (ABET) and the instructors' course learning outcomes will be mapped to the Educational Objectives. Strengths and weaknesses will be identified and used to establish any necessary improvements to the ARE curriculum. This outcomes assessment will continue annually through the ABET accreditation process, and will then be conducted prior to each ABET review thereafter. The outcomes assessment will also be conducted prior to each OSU Undergraduate Academic Program Review, if an ABET review has not occurred in the same academic year.

The ARE capstone courses are designed to address ABET outcomes (as shown in Table 6). The ARE capstone course will focus on the iterative design of an authentic architectural engineering design project by students working in groups of three to four. The students will develop multiple written documents, including engineering plans and reports. They will also engage in and reflect upon their roles as group members, leaders, and mentors as they progress in their designs. Students will also reflect upon the design decisions they make as they relate to engineering ethics. This multitude of experiences will relate to the ABET outcomes. A holistic plan for the assessment and improvement of these outcomes will be established as part of the course planning process. A sample assessment plan is provided in the supporting documents. The proposed process is very similar to that followed by Civil Engineering (CE).

Table 5: Template for Course Summary for Undergraduate Course

Course Summary for REQUIRED UNDERGRADUATE Course

1) **SYLLABUS FOLLOWING OSU MINIMUM REQUIREMENTS**

2) **LIST ALL ABET STUDENT OUTCOMES (1-7) INCLUDED IN THE COURSE**

3) **LIST ALL COURSE LEARNING OUTCOMES FOR THE COURSE**

Course Learning Outcome	**Assessments** (HW, quiz, lab, project, specific exam questions) (at least 2)	**Assessment Results** % passing (>70%)
1	1)	
	2)	
		Mean of above:
2	1)	
	2)	
		Mean of above:
etc.	1)	
	2)	
		Mean of above:

ABET Student Outcome Relevant to course	**Assessments** (HW, quiz, lab, project, specific exam questions) (at least 2)	**Assessment Results** % passing (>70%)
1	1)	
	2)	
		Mean of above:
2	1)	
	2)	
		Mean of above:
etc.	1)	
	2)	
		Mean of above:

Improvements made this term to improve student performance (identify Student Outcome addressed):

Improvements needed next course offering (identify Student Outcome addressed):

Table 6: Architectural Engineering Curriculum Map with Student Outcomes (Part 1 of 2)

Architectural Engineering Courses	Credit Hours	Student Outcomes						
Baccalaureate Core Classes		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Social Processes and Institutions - Introduction to Micro-Economics ECON 201	4					x		
Biological Science (1 course)	4	x		x				
Lifetime Fitness for Health HHS 231	2							
PAC/HHS (1 course)	1							
Literature and the Arts - History of Western Architecture ART210	3					x		
Mathematics, Statistics, Physics, Chemistry		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Differential Calculus MTH 251[E]	4	x						
Integral Calculus MTH 252[E]	4	x						
Vector Calculus I MTH 254[E]	4	x						
Applied Differential Equations MTH 256[E]	4	x						
Matrix and Power Series Methods MTH 306[E]	4	x						
Introduction to Statistics for Engineers ST 314[E]	3	x						
General Physics with Calculus PH 211[E]	4	x						
General Physics with Calculus PH 212[E]	4	x						
Chemistry for Engineering Majors CH 201[E]	3	x						
General Civil/Construction/Architectural		**1**	**2**	**3**	**4**	**5**	**6**	**7**
CCE Orientation CCE 101	2	x				x	x	
Problem Solving & Technology CCE 102[E]	3							x
Graphics & Design CCE 201[E]	3	x	x		x			x
Plane Surveying CEM263	3	x		x				
Intro. to Virtual Design and Construction CCE 203	3		x	x				x
ARE Junior Seminar ARE 301	1					x	x	
Structural Engineering		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Statics ENGR 211[E]	3	x			x			
Dynamics ENGR 212[E]	3	x						
Strength of Materials ENGR 213[E]	3	x	x					
Structural Theory I CE 381[C]	4	x						
Structural Theory II CE 382[C]	4	x						
Design of Steel Structures CE 383[C]	4	x	x		x			x
Reinforced Concrete I CE 481[C]	4	x	x					
Wood Design CE 484[C]	4	x	x					

E - Required by College of Engineering for entry into the Professional Program (used to calculate GPA)

C - Core courses for the Professional Program; used to calculate GPA

^ - writing intensive course (WIC)

* - approval required for courses other than those listed

Table 6, cont'd. Architectural Engineering Curriculum Map with Student Outcomes (Part 2 of 2)

Construction Engineering and Management		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Construction Estimating I CEM 341[C]	4	x						
Engineering Planning CE 420[C]	4	x	x					x
Building Construction Management CEM 442[C]	4	x						x
Advanced Building Construction Methods ARE 451[C]	4	x	x					x
Mechanical, Electrical, Plumbing, Fire Protection		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Electrical Fundamentals I ENGR 201	3	x	x	x				
Electrical Facilities CEM 471[C]	4	x	x					
Design of Electrical and Illumination Systems for Buildings ARE 352[C]	4	x	x					
Hydraulics CEM 311	4	x						
Mechanical Facilities CEM 472[C]	3	x						
Design of HVAC Systems for Buildings ARE 353[C]	4	x	x					
Other Technical Topics		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Civil and Construction Engineering Materials CCE 321[C]	4	x	x	x	x			
Geotechnical Engineering I CE 372[C]	4	x		x				
Green Building Materials CCE 422[C]	3	x	x			x		
Capstone Design		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Architectural Engineering Professional Practice/Capstone 1 ARE 418 ^[C]	4	x	x	x	x	x	x	x
Architectural Engineering Design/Capstone 2 ARE 419^[C]	3	x	x	x	x	x	x	x
Technical Electives* (Choose 7 credit hours)		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Masonry Design CE 482	3	x	x					
Temporary Construction Structures CE 427	4	x	x					
Selected Topics in Structural Design CE 480/580	3	x	x					
Geotechnical Engineering II CE 373	4	x	x					
Advanced Wood Design WSE 592	4	x	x		x	x		x
Contracts & Specifications CE 424	4				x	x	x	x
Project Management for Construction CEM 443	4				x	x		
Obtaining Construction Contracts CEM 431	4	x			x			x
Transportation Facility Design CE 594	4	x	x		x	x		
Energy Analysis ARE XXX	4	x	x					
Controls ARE XXX	4	x	x					
Fire Protection Design ARE XXX	4	x	x					
Other elective(s) ARE XXX	4	x	x					
Free elective, if needed	1	x	x					

E - Required by College of Engineering for entry into the Professional Program (used to calculate GPA)
C - Core courses for the Professional Program; used to calculate GPA
^ - writing intensive course (WIC)
* - approval required for courses other than those listed

c. Program performance indicators, including prospects for success of program graduates (employment or graduate school) and consideration of licensure, if appropriate.

Program performance indicators to be measured include:

- Number of students enrolled
- Retention and graduation rates
- Employment upon graduation or enrollment in graduate school
- Number of graduates obtaining licensure
- Student satisfaction from exit surveys / interviews
- Employer satisfaction from surveys which are done annually for graduates, alumni with 5 years of experience, and employers

d. Nature and level of research and/or scholarly work expected of program faculty; indicators of success in those areas.

The majority of faculty who would be added to the program could develop strong extramurally funded research from national and state agencies, as well as foundations and private industry. It is anticipated that faculty added to the program would produce high quality scholarship. The number and quality of peer-reviewed scholarship and the availability of research funding will be the primary indicators of success. Performance parameters continually collected by the College of Engineering include:

• Scholarly publication (CCE averaged 3.11 journal publications per FTE)

• Participation in professional meetings, conferences and workshops (CCE faculty members have been very active in service activities)

• External funding for research (CCE has approximately 7.1 million dollars of funded research during the last year with over $200,000 in annual expenditures per faculty; this is a number that has risen by over 40% since 2013)

• Number and magnitude of proposals written

• Participation in professional societies, committees, boards, and commissions (CCE faculty members have been very active in service activities)

• Commercial development including disclosures, patents and start-up companies

These indicators are evaluated each year in the faculty member's annual review.

6. Program Integration and Collaboration

a. Closely related programs in other OUS universities and Oregon private institutions.

The proposed ARE degree program would be the only one of its kind in the state of Oregon. As mentioned previously, Mt. Hood Community College has a 2-year degree program that prepares their graduates to work as architectural engineering technicians who assist engineers, architects and other industry professionals. The geographically

closest 4-year degree program in architectural engineering is in southern California. That program is largely focused on structural engineering; the closest 4-year programs that provide a more comprehensive architectural engineering education are in Wyoming and Colorado.

b. Ways in which the program complements other similar programs in other Oregon institutions and other related programs at this institution. Proposal should identify the potential for collaboration.

The proposed ARE program complements related programs in Architecture (U. Oregon), Civil & Construction Engineering (CCE) and Wood Science & Engineering (WSE) at this institution. As described in the Program Description (Section 1), the ARE curriculum heavily leverages existing engineering courses in CCE (as well as other potential offerings in the COE) and includes WSE among its technical electives. The course of study complements existing curricula in structural engineering and construction engineering and management by providing new courses in the engineering of the building's heating, ventilation, air-conditioning, lighting and electrical systems and building materials. The result will be a comprehensive course of study in the engineering sciences of buildings and their systems.

Through WSE in the College of Forestry, the proposed curriculum will also build upon a partnership with the Department of Architecture at the University of Oregon for architectural studio / capstone design courses. Furthermore, the proposed Architectural Engineering program complements the Department of Architecture through work related to building energy. Architecture faculty have worked on topics such as daylighting and shading, building facades, natural ventilation, human comfort (indoor environments), and sustainable cities. Collaboration on these and related topics, merging architecture and the engineering sciences for buildings, would strengthen the outcomes for sustainable and high performance buildings.

The proposed program complements the existing Mt. Hood Community College (MHCC) Architectural Engineering Technology program by educating engineers who would work with the technicians who graduate with an MHCC Associate of Applied Science Degree. The proposed program may also provide additional opportunities for MHCC Architectural Engineering Technology graduates. MHCC is part of OSU's Degree Partnership Program (DPP), which allows students to transition to OSU easily. As noted by Mike Brayson, MHCC Advisor of Architectural Engineering Technology, in his letter of support for the proposed degree program: "Technical tools and modeling software used in the AEC market has evolved over the last decade ..." and "Oregon and the building construction industry needs a program like this. The application of these emerging technologies, in both scope and depth, goes well beyond what we can cover with a two year community college experience."

c. If applicable, proposal should state why this program may not be collaborating with existing similar programs.

Not Applicable.

d. Potential impacts on other programs in the areas of budget, enrollment, faculty workload, and facilities use.

The creation of an ARE program at OSU is not expected to affect the budget, enrollment, faculty workload or facilities use of any other programs in Oregon outside of OSU. The only potential impact is in the area of potential collaboration with the University of Oregon's Architecture program and Oregon State's Wood Science and Engineering School.

The impact of the ARE program at OSU is positive. This program satisfies an unmet educational need, increases enrollment at the campus, can increase diversity, and increases utilization of the facilities. It is projected that the program will be self-sustaining.

7. Financial Sustainability (attach the completed *Budget Outline*)

a. Business plan for the program that anticipates and provides for its long-term financial viability, addressing anticipated sources of funds, the ability to recruit and retain faculty, and plans for assuring adequate library support over the long term.

The costs of student recruiting visits, program promotion and management of the ARE program will be paid using the existing budget within the School of Civil and Construction Engineering. The costs for these activities are estimated at $7,500 per year.

The College of Engineering has planned to add two new faculty members with an ARE emphasis to CCE. The annual cost for ARE in terms of tenure track faculty, professional faculty and teaching assistants is $228,696 for the first year and $402,787 for the second year as outlined in the budget.

For the program to be successful, there will also need to be some administrative and advising support. We expect, for example, that the CCE Operations Manager and communications professional will need to devote approximately 10% of her annual effort to this program. The expected enrollment for any given new course is less than 40 students per year, as shown in Table 4.

b. Plans for development and maintenance of unique resources (buildings, laboratories, technology) necessary to offer a quality program in this field.

Facilities and resources from the College of Engineering and Civil and Construction Engineering are more than adequate to support the proposed programs in ARE. CCE currently has space in Kearney, Owen, Merryfield, and Graf Hall. The Complex for Resilient Infrastructure and Safety (CRIS) is currently under design with a target completion date of Fall 2018. Faculty would have offices in Owen, while laboratories could be in existing spaces or the new CRIS facility. No additional facilities or resources will be required.

c. Targeted student/faculty ratio (student FTE divided by faculty FTE).

As previously mentioned, the program would be developed with the addition of two new FTE as well as a professional faculty member with a 50% appointment. If one considers that 100 students will be enrolled in the program by the 4th year this would be a student to faculty ratio of 50:1; however, as the faculty primarily work closely with the students in year 3 and 4 the actual ratio is approximately 25:1.

d. Resources to be devoted to student recruitment.

Student recruitment involves both program promotion, as well as recruiting visits for students who have applied and been accepted into the program. Resources for program promotion include the costs of brochures, mailing, and webpage maintenance. Existing CCE staff will be utilized for development of marketing materials as well as advising. In the first two years of the new ARE graduate program, we anticipate relatively high promotion costs of about $7,500 per year in order to create promotional materials, build a new website for the program as well as more comprehensive efforts to promote the launch of the program (including top student recruitment and visits). In the long term, the costs of program promotion and student recruitment are estimated at about $10,000 per year. This cost will be paid by the School of Civil and Construction Engineering.

8. External Review (if the proposed program is a graduate level program, follow the guidelines provided in *External Review of new Graduate Level Academic Programs* in addition to completing all of the above information)

Not applicable at this time.