2019-2020 Annual Assessment Report for the Bachelor of Science in Engineering

Name of program: B.S. in Engineering
Type of program: Major
College of Arts and Sciences

List of Tables and Figures

I. Logistics

1. Contact information

Feedback should be sent to the Chair of the department, Hana Böttger (hana.bottger@usfca.edu).

2. Type of program

This is a report for the BS in Engineering major. The B.S. in Engineering does not house minors yet. Affiliated minors not discussed here:

- Engineering Physics minor, housed under the department of Physics & Astronomy
- Architectural Engineering minor, housed under the department of Art + Architecture

3. Curriculum

The engineering program has three concentrations, one of which must be declared by each Engineering major in the latter half of the curriculum: environmental engineering, sustainable built environments engineering, and electrical & computer engineering.

Table 1, Table 2 and Table 3 describe the level at which each ENGR course addresses each of the seven learning outcomes in the EnvE, SBE and ECE concentrations respectively. The Engineering major follows the requirements of ABET, the professional accreditation body for engineering and technical programs. For each of the seven ABET Student Outcomes (SO's) corresponding to the program's PLOs, a designation of introducing, developing or mastery is given, depending on the level at which each PLOs is taught/addressed in each course. The curriculum map is used to guide the process of assessment in multiple ways. The program intends to ensure that all PLOs are addressed and that for all PLOs, the curriculum introduces the material, before expecting development and mastery of the learning objectives. It should be noted that these three levels are distinct from the levels at which students are expected to perform within each course, which will be described later in the Assessment Process section.

Table 1: Curriculum map for Environmental Engineering (EnvE) courses

Mapping ABET Student Outcomes to Environmental Engineering concentration					•	introducing					
					O	developing					
					M	mastery					
					ABET Student Outcomes						
YEAR	Semester	Credits	Course	course/type	1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	3. communicate effectively with a range of audiences	4. 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	5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	6. develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	7. acquire and apply new knowledge as needed, using appropriate learning strategies.
0	Summer	1	Intro to USF Engineering	ENGR 001	•	•	•	•	•		•
1	Fall	2	Becoming an Engineer	ENGR 100			•	•	•		•
1	Fall	4	Calculus I	MATH/B1	•		•				•
1	Fall	4	Gen Physics I for Engineers	PHYS/B2	•		•		•	•	•
1	Spring	4	Calculus II	MATH	•		•				•
1	Spring	2	Programming for Engineers	ENGR 102X	•	•	•		•		•
1	Spring	4	Gen Physics II for Engineers	PHYS	O	•	•		•	O	O
1	Spring	4	Engineering Project and Design I	ENGR 110/A1	O	O	O	•	O		
1	Summer	4	Engineering Outreach Immersion	NGR 140/CD,CEI	O	•	O	O	O	•	O
2	Fall	4	Multivariable Calc		O	O	O		O	O	O
2	Fall	4	Scientific Computing								
2	Fall	4	Sensors & instruments through History	ENGR 134							
2	Fall	4	Gen Chemistry I for Engineers	CHEM	•					•	
2	Spring	4	Math Methods for Scientists & Engineers	PHYS 371							
2	Spring	4	Sustainable Systems	ENGR 240	O		•			O	O
2	Spring	4	Engineering Project and Design II	ENGR 210	O	O	O	O	O	O	O
2	Spring	4	Gen Chem II for engineers (with lab)		•		•		•	O	
3	Fall	16-18	*concentration area requirements, electives and core*								
3	Fall	4	Fluid Mechanics		O	•	•		•	•	
3	Spring	4	Engineering Project and Design III	ENGR 310	O	O	O	O	O	O	O
3	Spring	12-14	*concentration area requirements, electives and core*								
3	Spring	4	Environmental Engineering		O	•	•	•	O		O
4	Fall	2	Project IV: capstone part I	ENGR 410	M	M	M	M	M	M	M
4	Fall	14-16	*concentration area requirements, electives and core*								
4	Fall	4	Water and Wastewater Treatment		M	O	O	O	M	O	M
4	Spring	2	Project IV: capstone part II	ENGR 411	M	M	M	M	M	M	M
4	Fall	14-16	*concentration area requirements, electives and core*								

Table 2:Curriculum map for Sustainable Built Environment (SBE) Engineering courses

Mapping ABET Student Outcomes to Sustainable Built Environment concentration

• introducing
O developing
M mastery

YEAR	Semester	Credits	Course	course/type	ABET Student Outcomes: 1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	3. communicate effectively with a range of audiences	4. 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	5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	6. develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	7. acquire and apply new knowledge as needed, using appropriate learning strategies.
0	Summer	1	Intro to USF Engineering	ENGR 001	•	•	•	•	•		•
1	Fall	2	Becoming an Engineer	ENGR 100			•	•	•		•
1	Fall	4	Calculus I	MATH/B1	•		•				•
1	Fall	4	Gen Physics I for Engineers	PHYS/B2	•		•		•	•	•
1	Spring	4	Calculus II	MATH	•		•				•
1	Spring	2	Programming for Engineers	ENGR 102X	•	•	•		•		•
1	Spring	4	Gen Physics II for Engineers	PHYS	O	•	•		•	O	O
1	Spring	4	Engineering Project and Design I	ENGR 110/A1	O	O	O	•	O		
1	Summer	4	Engineering Outreach Immersion	:NGR 140/CD,CEI	O	•	O	O	O	•	O
2	Fall	4	Multivariable Calc		O	O	O		O	O	O
2	Fall	4	Scientific Computing								
2	Fall	4	Sensors & instruments through History	ENGR 134							
2	Fall	4	Gen Chemistry I for Engineers	CHEM	•					•	
2	Spring	4	Math Methods for Scientists & Engineers	PHYS 371							
2	Spring	4	Sustainable Systems	ENGR 240							
2	Spring	4	Engineering Project and Design II	ENGR 210	O	O	O	O	O	O	O
2	Spring	4	Statics & Structural Engineering		O	O	O		O		O
3	Fall	*16-18*	*concentration area requirements, electives and core*								
2	Spring	4	Construction Materials				O	O	O	O	O
3	Spring	4	Engineering Project and Design III	ENGR 310	O	O	O	O	O	O	O
3	Spring	*12-14*	*concentration area requirements, electives and core*								
3	Spring	4	Experimental Methods		M	M	M	M	M	M	M
4	Fall	2	Project IV: capstone part I	ENGR 410	M	M	M	M	M	M	M
4	Fall	*14-16*	*concentration area requirements, electives and core*								
4	Fall	4	Sustainable Urban Systems		M		M	M	M		M
4	Spring	2	Project IV: capstone part II	ENGR 411	M	M	M	M	M	M	M
4	Fall	*14-16*	*concentration area requirements, electives and core*								

Table 3:Curriculum map for Electrical Engineering (EE) courses

Mapping ABET Student Outcomes to Electrical Engineering/Computer Science concentrat

• introducing
O developing
M mastery

YEAR	Semester	Credits	Course	course/type	ABET Student Outcomes: 1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	3. communicate effectively with a range of audiences	4. 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	5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	6. develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	7. acquire and apply new knowledge as needed, using appropriate learning strategies.
0	Summer	1	Intro to USF Engineering	ENGR 001	•	•	•	•	•		•
1	Fall	2	Becoming an Engineer	ENGR 100			•	•	•		•
1	Fall	4	Calculus I	MATH/B1	•		•				•
1	Fall	4	Gen Physics I for Engineers	PHYS/B2	•		•		•	•	•
1	Spring	4	Calculus II	MATH	•		•				•
1	Spring	2	Programming for Engineers	ENGR 102X	•	•	•		•		•
1	Spring	4	Gen Physics II for Engineers	PHYS	O	•	•		•	O	O
1	Spring	4	Engineering Project and Design I	ENGR 110/A1	O	O	O	•	O		
1	Summer	4	Engineering Outreach Immersion	NGR 140/CD,CE	O	•	O	O	O	•	O
2	Fall	4	Multivariable Calc		O	O	O		O	O	O
2	Fall	4	Scientific Computing								
2	Fall	4	Sensors & instruments through History	ENGR 134							
2	Fall	4	Gen Chemistry I for Engineers	CHEM	•					•	
2	Spring	4	Math Methods for Scientists & Engineers	PHYS 371							
2	Spring	4	Sustainable Systems	ENGR 240							
2	Spring	4	Engineering Project and Design II	ENGR 210	O	O	O	O	O	O	O
2	Spring	4	Digital Electronics		O	O	O	•	O	O	O
3	Fall	*16-18*	*concentration area requirements, electives and core*								
3	Fall	4	Analog Electronics		O	O	O	•	O	O	O
3	Spring	4	Engineering Project and Design III	ENGR 310	O	O	O	O	O	O	O
3	Spring	*12-14*	*concentration area requirements, electives and core*								
3	Spring	4	Sensors and instruments		M	M	O	•	O	M	O
4	Fall	2	Project IV: capstone part I	ENGR 410	M	M	M	M	M	M	M
4	Fall	*14-16*	*concentration area requirements, electives and core*								
4	Fall	4	Feedback controls		M	M	O	•	O	M	O
4	Spring	2	Project IV: capstone part II	ENGR 411	M	M	M	M	M	M	M
4	Fall	*14-16*	*concentration area requirements, electives and core*								

II. Mission statement and Program Learning Outcomes

Note: The department of Engineering plans to apply for accreditation by ABET, the international accreditation agency for engineering programs. . ABET requires accredited programs to have Program Educational Objectives (PEO's) and Student Objectives (SO's) rather than Program Learning Outcomes. USF's PLO's correspond to ABET's SO's. The department of Engineering at USF will be following the seven SO's prescribed by ABET, with the assessment criteria being such that they are aligned with USF's mission, and based on educational theory.

1. Changes in mission statement since last assessment cycle

No changes. This is the first mission statement we are submitting for the B.S. in Engineering.

Mission Statement

USF Engineering's mission is to educate the whole person in the Ignatian tradition of transforming the world and ourselves. Through an innovative, inclusive, and applied education focusing on design, creation, and resourcefulness, it provides students the skills and perspective they need to succeed as professionals and the self-confidence, sensitivity, empathy, and cultural competency necessary to be ethical and responsible engineers empowered to effect meaningful change. It is distinguished by its high-quality, community-engaged scholarship, teaching, and research, and its interdisciplinary programming relevant to real projects locally, regionally, and internationally.

2. Changes in program learning outcomes since last assessment cycle

No changes. This is the first time we are submitting our PLOs since the establishment of the program.

a) Program Educational Objectives (PEOs)

USF Engineering succeeds in its mission by graduating students who meet our four educational objectives to:

1. Demonstrate fluency with design thinking, systems thinking, creative problem solving, and self-directed scholarship as modes of approaching the engineering process.
2. Implement a holistic approach to engineering which values context, integrates multiple perspectives through collaborative teamwork, questions need, and considers impacts on both individuals and society at large.

3. Lead responsibly through a fusion of engineering judgement, practice, and entrepreneurship, while representing the engineer's critical role in projects, organizations, the environment, and society.
4. Exhibit a professional and personal identity which upholds values of social justice, environmental sustainability, and respectful service even under unknown and challenging conditions.

b) ENGR Program Learning Outcomes (PLOs)

Our degree program will be meeting the requirements for professional accreditation by ABET, the agency which oversees accreditation of engineering programs. ABET requires a two-part statement of outcomes – in addition to the *Program Educational Objectives* stated above as part of the Mission, we will meet the following *Student Outcomes*.

Students will achieve:

- PLO1: An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
- PLO2: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
- PLO3: An ability to communicate effectively with a range of audiences
- PLO4: An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
- PLO5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
- PLO6: An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions
- PLO7: An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

These program learning outcomes were approved by the department in a general meeting of the curriculum committee in the Fall of 2018.

c) PLOs to ILOs mapping

Table 4 describes when and how each program learning outcomes (PLOs) for the B.S. in ENGR degree maps onto the Institutional Learning Outcomes (ILOs) for the University of San Francisco. The ILOs are also detailed below for easy reference.

Table 4:Mapping of ENGR PLOs to USF ILOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
ILO1				x			
ILO2	x					x	
ILO3		x					
ILO4			x		x		
ILO5	x	x				x	
ILO6	x	x				x	x
ILO7				x			

Institutional Learning Outcomes for the University of San Francisco

1. Students reflect on and analyze their attitudes, beliefs, values and assumptions about diverse communities and cultures and contribute to the common good (Critical Thinking)
2. Students explain and apply disciplinary concepts, practices and ethics of their chosen academic discipline in diverse communities (Critical Thinking)
3. Students construct, interpret, analyze and evaluate information and ideas derived from a multitude of sources (Critical thinking; quantitative reasoning; information literacy)
4. Students communicate effectively in written and oral forms to interact with their personal and professional communities (Written and oral communication)
5. Students use technology to access and communicate information in their personal and professional lives (component of information literacy)
6. Students use multiple methods of inquiry and research processes to answer questions and solve problems (Critical thinking; quantitative reasoning; information literacy)
7. Students describe, analyze, and evaluate global interconnectedness in social, economic, environmental and political systems that shape diverse groups within the San Francisco Bay Area and the world (Critical Thinking)

d) Program Learning Outcomes assessed in 2019-2020

None, since the program was not in place.

e) Program Learning Outcomes to be assessed in 2020-2021

The following two learning outcomes were chosen based on the outcomes assessed in first year courses. Between PLO3, PLO5, and PLO7, we chose PLO3 as a priority to establish a baseline that we can compare to next year.

1. PLO1: An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. PLO3: An ability to communicate effectively with a range of audiences

Table 5 shows the mapping of the assessed PLOs to courses taught during the academic year 2020-2021, from which data will be collected for the first assessment round. Symbol X means that the PLO is taught in the course, and Data means that data will be collected for assessment purposes in year 1.

Table 5: Courses taught during AY 2020-2021. X marks indicate the PLOs addressed by each course, and D marks indicate courses that will be contributing data for the assessment process during AY 2020-2021.

	ENGR100 (Fall)	**ENGR110 (Fall)**	**PHYS150 (Fall)**	**PHY151 (Spring)**	**ENGR102 (Spring)**
PLO1			**X/D**	**X/D**	**X/D**
PLO2		X	X		X
PLO3		**X/D**	**X**	**X**	
PLO4	X	X	X		
PLO5	X	X		X	
PLO6				X	
PLO7	X	X		X	X

3. Methodology for assessment

a) Overview and Rationale

The seven program learning outcomes will be assessed on a cognitive and a knowledge dimension[1]. In the cognitive dimension, the following four steps are envisioned to describe the learning of engineering students: a) Understanding, b) Applying, c) Analyzing, and d) Designing. The first two steps are expected to be met in courses taught in Years 1 and 2 of the curriculum. The second two steps of the cognitive scale are expected to be met in courses taught in Years 3 and 4. By differentiating between the two stages of learning, we ensure that for all PLOs students first encounter basic cognitive processes, and then transition to more advanced cognitive processes, like design. This addresses the problem of expecting courses and students to reach a design-oriented PLO, without having succeeded in the more basic criterion of understanding and applying.

[1] Anderson, L. W., & Bloom, B. S. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

In the knowledge dimension, there are four different levels: factual, conceptual, procedural, and meta cognition. For the purposes of assessment, we examine 3 of the knowledge dimensions, with the exception of PLO7, which focuses solely on the fourth knowledge dimension - meta cognition. These levels are not required to be consecutive in nature. It is possible that a student is able to describe the procedure of solving a problem, without being able to demonstrate understanding of the concepts related to the problem at hand. All levels of the knowledge dimension can be reached for any given cognitive process dimension level. Table 6 illustrates the four levels in the cognitive process dimension and the three levels in the knowledge dimension.

Table 6: Two-dimensional map used to determine assessment criteria for any given ENGR PLO. Each PLO is assessed at the knowledge and cognitive process level chosen by the instructor.

		Cognitive Process Dimension -->			
		Formative assessment		**Summative assessment**	
USF ENGR outcomes: A student who has mastered this level should be able to		**Understanding: recall what you learn and define, explain or give examples to others**	**Applying: using information to accomplish something concrete**	**Analyzing: being able to extract meaning from a collection of information**	**Designing: creating something new under constraints to achieve a near optimal outcome**
PLO description	**Knowledge dimension**	Factual (1-4)	Factual (1-4)	Factual (1-4)	Factual (1-4)
		Conceptual (1-4)	Conceptual (1-4)	Conceptual (1-4)	Conceptual (1-4)
		Procedural (1-4)	Procedural (1-4)	Procedural (1-4)	Procedural (1-4)

In summary, curriculum-wide and at the end of the fourth year, we would like students to be able to demonstrate achievement on all knowledge dimensions, and at the highest cognitive process dimension possible. It is possible that the engineering faculty could decide that the “designing” level of the cognitive process dimension may be more appropriate for a graduate degree.

The advantages of the proposed two-dimensional scale are to allow the program to:

- Ground the assessment in educational theory (Anderson & Bloom, 2001) and align the assessment of student achievement to the process of student learning throughout the curriculum.
- Add more granularity in the steps of student learning. More specifically, the scheme allows for a stepwise approach to assessing each PLO. For example, if we are noticing

students are not achieving the “applying” criterion, the instructor can assess understanding.

- Use different knowledge dimensions as they apply to different types of courses: for example, labs are appropriate for procedural knowledge assessment, whereas lecture-based classes are more appropriate for facts and concepts assessment.
- Provide guidance to the instructor on elements of learning that should be targeted. In the original rubrics, multiple performance indicators were grouped under one PLO, which were mapped to different levels of the knowledge and cognitive process dimensions.
- Allow the program to assess whether all necessary stages of cognitive and embodied learning are covered in the curriculum to guide future adjustments.

b) Criteria and Rubrics for assessment

Assessment criteria were developed for the assessment of every knowledge-cognitive process dimension combination for PLOs 1 and 3. As outlined in the next section, each instructor will choose one or more of these criteria to assess PLO1 and PLO3, depending on the nature of their course. Examples for how this was done for two courses during semester 1 are given later in this document. General rubrics for each criterion will be provided, and the instructor should adapt the rubric to match the specific expectations of the work product and the course.

i. PLO1 for the B.S. in Engineering

For PLO1 of the B.S. in Engineering (ENGR), students will be able to demonstrate an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics.
In the first phase of the engineering curriculum development, *performance indicators* were developed for each program learning outcome. These performance indicators span the entire range of the cognitive process dimension and the knowledge dimension. For PLO1, the mapping between performance indicators and the assessment criteria is shown in Table 7. It is expected that not all work products will be appropriate for all performance indicators, corresponding to the level of knowledge expected at each phase of a course. Instructors can choose one or more of these performance indicators. Choosing multiple performance indicators (e.g., Understanding factual, and applying factual, or understanding factual and understanding procedural) is optional, but can be beneficial because it can provide data for comparisons.

Table 7: Mapping of performance indicators to knowledge-cognitive process level for PLO1

Performance indicators	Knowledge-cognitive process dimension
Identify specific facts of math, science and engineering germane to a problem	Understanding-Factual

Formulate the problem and identify key issues/variables	Applying-factual
Convert real world description into an appropriate model	Applying-conceptual
Demonstrate proper use of math, science and engineering knowledge to obtain desired performance goals	Applying-procedural
Analyze & justify a solution to an engineering problem	Analyzing-conceptual/procedural

A rubric for the understanding-factual dimension is given in Table 8:

Table 8: Rubric for assessing the understanding-factual dimension for PLO1. The rubric can be further adapted to become more specific to the working product being assessed by the instructor.

Assessment criterion	1. Introductory	2. Developing	3. Meets expectations	4. Exceeds expectations
explain the meaning of equations, engineering units, terms, and facts and/or a context in which they are used.	superficial ability to identify facts, many facts missing	identifies some important facts, while other significant facts are missing	identifies most of the key facts	identifies all known facts for the given situation

Table 9 illustrates all four cognitive process dimensions for PLO1 and the three knowledge dimensions. Only the colored criteria of this table are deemed appropriate for assessment in Years 1 and 2.

Table 9: The four cognitive process dimensions for PLO1 and the three knowledge dimensions

	Cognitive Process Dimension -->			
	Formative assessment (Years 1-2)		**Summative assessment (Years 3-4)**	
	Understanding: recall what you learn and define, explain or give examples to others	**Applying: using information to accomplish something concrete**	**Analyzing: being able to extract meaning from a collection of information**	**Designing: creating something new under constraints to achieve a near optimal outcome**
Knowledge dimension -->	F - explain the meaning of equations, engineering units, terms, and facts and/or a context in which they are used.	F - use correct terms, facts and units when solving problems	F - manage unnecessary or conflicting information and/or explain the factual basis of a problem.	F - find and use facts needed to solve a problem from textbooks, on-line resources, databases, or other technical documentation.
	C - explain a concept or interrelation between ideas correctly in their own words or through a drawing or example.	C - use concepts learned to solve or frame a problem or express concept through appropriate technical forms	C - make predictions or test theories using concepts and/or draw from multiple concepts to solve a problem.	C - apply systems thinking concepts to engineering problem solving and design
	P - explain/identify a problem, principles, design steps, or research method for an engineering problem	P - decompose problem and create and solve a quantitative of qualitative model or process	P - analyze measurement data to determine if a device is functioning to specification.	P - research, model, measure, test and iterate through solutions of self-identified problems

The instructor will choose the criteria that make sense for the chosen work products and will assess them using the rubric provided on a scale 1-4, on Canvas. The instructor will be expected to submit:

- An explanation of which criterion/a were selected
- A description of the work product they used
- The specific rubric they used, if different from the one provided, to submit the assessment. Specific rubrics are encouraged to allow for better quality data for validation/revisiting of the results in future assessments (random blind assessments for quality assurance/quality control (QA/QC)

  A detailed process is provided under section “Tentative process for first round of assessment”.

ii. PLO3 for the B.S. in Engineering

For PLO3 students will demonstrate an ability to communicate effectively with a range of audiences. Table 10 lists the original performance indicators developed for PLO3. More performance indicators may be appropriate depending on the work product being assessed. In addition, the knowledge dimensions for PLO3 are still under development and feedback is welcome. One of the key questions is whether communications strategies (the process of it) are explicitly taught to students (factual knowledge dimension), or are they only implicitly taught through faculty feedback (procedural knowledge dimension).

Table 10: Mapping of performance indicators to knowledge-cognitive process levels for PLO3

Performance indicators	Knowledge-cognitive process dimension
Organize material	Applying-Factual
provide data both verbally and graphically to inform audience	Applying-procedural
Procedural Communication - Breaking a problem or system down into simpler or component parts to arrive at a solution.	Applying-procedural
Empathetic Interviewing	Applying-procedural
Deliver an oral presentation and respond to feedback from an audience	Applying-procedural
Communicating written technical content	Applying-procedural

A rubric for the applying-procedural dimension is given in Table 11:

Table 11: Rubric for evaluating the applying-procedural level for PLO3

Performance Indicator	1. Introductory	2. Developing	3. Meets expectations	4. Exceeds expectations
Empathetic Interviewing	User experience is not appreciated. *describes user experience *actively discounts or invalidates the user experience in write up	identifies the usefulness of user experience - paraphrases or summaries the experience, yet does not integrate the findings into design or other decisions	The user experience is recognized as valuable, and actively integrates user experience in design. There may be some confusion in terms of comprehension. The student uses empathetic techniques, such as paraphrasing and mirroring.	language integrates client-based experiences by using summary, paraphrase, and quotations to provide attribution to client, stakeholder and/or audience-related statements. Shares client/stakeholder's story by illustrating audience needs, problems and their priorities using empathic techniques and language.

Table 12 illustrates the four cognitive process dimensions for PLO3 and the three knowledge dimensions. Only the colored cells of this table are deemed appropriate for assessment in Years 1 and 2. Topic for further study: whether a conceptual, factual knowledge dimension makes sense for the teaching of communication in engineering courses.

Table 12: The four cognitive process dimensions for PLO3 and the three knowledge dimensions

	Cognitive Process Dimension -->			
	Formative assessment		**Summative assessment**	
	Understanding: recall what you learn and define, explain or give examples to others	**Applying: using information to accomplish something concrete**	**Analyzing: being able to extract meaning from a collection of information**	**Designing: creating something new under constraints to achieve a near optimal outcome**
Knowledge dimension -->	F - Describe key element of effective presentations, and other forms of communication	F - Create communication products that incorporate the key elements of effective communication	F -Be able to identify key elements of effective communication in samples (not own work)	F - Be able to comment and design improvement strategies for communication work products
	C - Describe how communication supports other forms of engineering knowledge	C - use a communication technique, with another person, to engage in new understanding	C - be able to review transcript to identify how communication approaches were correctly used	C - Be able to create a communication approach based on an assessment of the context

	P - identify appropriate formats, styles, and information for communicating information to a given audience.	P - communicate and present at a level your audience can understand either in writing, through oral presentation, or at a meeting.	P - edit their own work or that of others for style and content for a particular audience.	P - produce or combine others' work to create a well-reasoned, data-driven argument or presentation.

The instructor will choose the criteria that make sense for the chosen work products and will assess them using the rubric provided on a scale 1-4, on Canvas. The instructor will be expected to submit:

- An explanation of which criterion/a were selected
- A description of the work product they used
- The specific rubric they used, if different from the one provided, to submit the assessment. Specific rubrics are encouraged to allow for better quality data for validation/revisiting of the results in future assessments (random blind assessments for QA/QC)

A detailed process is provided in the next section.

c) Tentative process for first assessment

The following steps outline the process that will be followed for identification of courses to be assessed, data collection and reporting.

At registration time (two months in advance of the beginning of each semester):

1. The assessment committee requests for each course to identify the PLOs that each instructor will be assessing in their course the upcoming year. Based on this, PLOs to be assessed for the upcoming year will be decided.

At the beginning of the semester:

2. Each instructor chooses a cognitive and a knowledge dimension for assessment as outlined in the previous section. The instructor can choose one or more pairs of cognitive and knowledge dimension combinations to assess, based on the characteristics of their class and the work product.
    - Example: Instructor chooses PLO1: Understanding and Conceptual. The general description of the corresponding assessment criterion is "explain a concept or interrelation between ideas correctly in their own words or through a drawing or example."
3. The instructor creates a work product to assess the chosen criterion. The instructor may need to adapt the rubric to make it more specific to their work product.

- Example: "Explain the concept of gravitational acceleration and how it connects to …"

4. At the time of grading of the work product, the instructor assesses the work product for each student directly on Canvas on the following scale, Introductory (1) , Developing (2), Meets expectations (3), Exceeds expectations (4) according to the rubric provided. The rubric can be adapted if necessary, to map to the specific expectations for the work product being evaluated, as in step 3.
5. The instructor will submit the following to the assessment team:
    - The work products assessed (for QA/QC)
    - A description of which part of the work products was assessed (e.g., question 1 of part 2 of work product 1)
    - Students responses (raw data)
    - A reflection on the experience + feedback for next year

   We expect the instructor will spend about 2-3 hours for preparation (steps 2-3) and another 2-3 hours on assessment of their work products while grading (step 4).

At the end of the semester:

6. The assessment team collects the data (work products and corresponding assessments) and writes a summary report including the following:
    - Make map of what has been assessed (chosen dimensions)
    - Complete quantitative analysis of the data
    - Assemble and summarize any relevant qualitative data
7. Assessment committee will write a summary report to submit to the department for review. This summary report will be used for the annual internal USF assessment.
8. Not all of this data will be necessary to be included for ABET assessment reporting.
9. Starting next year, Canvas will be set up to allow the assessment team to draw the data automatically from each course, anonymized to protect student identity. This first semester/year, to allow for more flexibility, the assessment team will ask instructors to include them as instructors in their courses to draw data, or provide the data in another manner.
10. Blind reviews comment: in the future, we will need a process to allow for blind reviews to ensure QA/QC in assessment. This will require additional resources to allow two independent reviewers to provide assessment of the chosen work products.

At the beginning of the upcoming semester:

11. One department meeting will be devoted to the discussion of the assessment report, and the collection of feedback for upcoming rounds of assessment.
12. Modifications will be proposed for improvement of the process and/or rubrics.

A summary of the above process is shown in Figure 1:

1. Identification of PLOs to be assessed	• Assessment committee discusses with instructors to develop PLOs to be assessed that semester and what work products will be used
2. Instructor chooses assessment criterion	• Review existing assessment criterion for PLO • Evaluate need for a different assessment criterion • Use existing or adapt rubric for work product
3. Instructor assesses work product while grading	• Four level scale • via Canvas
4. Instructor submits:	• Work products (QA/QC) • Description of work products • Raw data • A reflection on the experience
5. Assessment committee completes:	• Assessment map • Quant analysis • Summary of qualitative data
6. Annual assessment report submitted to USF	• Deadline: 12/4
7. Post assessment	• Data stored for analysis at ABET assessment • Discuss outcomes during department meeting • Provide feedback for improvement

Figure 1: Process for assessment followed during AY 2020-2021 for assessment of PLO1 and PIO3. The process will be adapted based on feedback collected in Step 7: Post assessment

d) Examples of assessment for Fall 2020

In this section, we provide an example for each one of the PLOs that will be assessed. The examples explain the continuum between the assessment criteria chosen, the corresponding levels in the two-dimensional matrix (Table 6) used for assessment, work products, and rubrics used to assess work products.

i. Example: PLO1

PLO1: identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

<u>Work product:</u> Two final exam questions

<u>Assessment criteria chosen and rubrics:</u>

1. Understanding -conceptual learning

Q: Tarzan swings through the jungle on a vine. At the lowest point of his swing, is the tension in the vine greater than, less than, or equal to the gravitational force on Tarzan? Explain.

Rubric for assessment

Assessment criterion	1. Introductory	2. Developing	3. Meets expectations	4. Exceeds expectations
Qualitative explanation of the relative strength of centripetal force and gravitational force	Identifies tension and gravity as forces but missing some key understanding such as force direction or presence of centripetal motion	Able to correctly identify the tension is greater but unable to explain clearly using technical vocabulary	Correctly identify the tension is greater and explain in terms of net force and centripetal acceleration	Correctly identify greater tension and explain fully and concisely, without introducing unnecessary factors or repetition

2. Applying - conceptual learning

Q: The first snow has just fallen and Jack has eagerly run to the top of his favorite sledding hill. Unfortunately, it barely snowed and there's a big patch of dirt and mud at the bottom of the slope. The hill has a slope of 20° and the mud patch with m_k = 0.90 is 3 m wide, as shown below. Jack and his sled have a combined mass of 75 kg. a) If Jack starts 10 m up the slope what will be his speed when he reaches the bottom, right before hitting the mud? [Included for context, not used for this PLO assessment. b) Will Jack get stuck in the mud or make it across the 3-m-patch?

Assessment criterion	1. Introductory	2. Developing	3. Meets expectations	4. Exceeds expectations
Use energy conservation and thermal energy concepts to determine if the sled crosses the mud.	*Identify energy conservation approach but unable to apply *Missing a key equation/component such as connection between friction and thermal energy	Identify potential, kinetic, and thermal energy components correctly but major error in solution or setup such as: *mix up initial/final energy terms from multiple positions *misinterpret mathematical result/model when answering concept question	Successful problem setup, solution, and conceptual answer with only minor calculation errors	Successful problem setup as an inequality, fully solved/simplified algebraically before plugging in values and answering concept question using the result

ii. Example: PLO3

PLO3: An ability to communicate effectively with a range of audiences

<u>Work product:</u> Mid-semester assignment. Reflection on Empathetic communication.

<u>Assessment criteria chosen and rubrics:</u>

The instructor (Julia Thompson) worked with David Ryan in Rhetoric to develop two assignments to assess communications - Empathetic Interviewing Skills in ENGR 110 & Technical Communication in PHYS 150. Both assignments focus on applying procedural understanding according to Blooms Taxonomy (Anderson & Bloom, 2001): *Communicate and/or present at a level your audience can understand either in writing, through oral presentation, or at a meeting.*

For Empathetic Interviewing in ENGR 110 - there was a series of lectures on empathetic interviewing techniques. This included specific skills, the value for engineering design, and discussion of primary literature from Carl Rogers. Students then needed to conduct an interview based on a project and write a 500-word reflection stating how they integrated empathetic communication into their interview. The assignment and rubric are below:

Assignment:

Creating a successful engineering project often starts with understanding the forensic context of the project, such as the problem, requirements, regulations, facts; and equally important are the human factors, such as insights, perspectives and emotions. of the stakeholders. Because client interaction is fundamental to understanding their needs, successful engineers work to develop empathy and trust by meeting and interviewing the stakeholders.

In a professional context, client interviews are often recorded via audio or video. If these methods are not available, then notating and documenting (in writing) are the next best means. In the early stages of information gathering, the strategy of listening with understanding is key to effectively responding to their needs.

Directions: for this assignment, compose a 500-word reflective paper that explains your project in relation to the discussions you and your team has had with your users.

To help compose your reflection, think about the ways in which, you:

- *interacted and interviewed your client(s) by asking questions that helped them explain their perspectives on the project.*
- *gathered information that helped your understanding of the project.*
- *integrated their ideas in your project.*
- *considered some of their ideas but ultimately did not use their ideas, and;*

- *learned to use an empathic understanding of audience-related needs to improve your communication skills.*

Rubric for assignment

Table 13: Rubric for evaluating PLO3 in the applying-procedural level using two performance indicators.

Performance Indicator	**1. Introductory**	**2. Developing**	**3. Meets expectations**	**4. Exceeds expectations**
Primary Research Method: Audience Assessment by Empathetic Interviewing to understand user experience.	Research method is not conducted or is poorly formulated and/or explained.	Research method is partially formulated and/or conducted; demonstrates partial understanding of empathic interview process.	Research method mostly explains audience needs; demonstrates sufficient understanding of empathic interview process.	Research method is primary by conducting mediated interviews; and integrates audience needs and priorities within problem-solving design scheme.
Problem-Solving and Writing: design, problem-solving and user experience language use empathy and storytelling to demonstrate sensitivity and understanding toward audience and stakeholder needs.	Design, problem-solving and user experience language are either not explained or is insufficiently described; user experience may also be actively discounted or invalidated.	Writer identifies design, problem-solving and user experience language by using paraphrase and/or summary techniques yet does not integrate audience needs or findings into design or other problem-solving decisions.	The user experience is recognized as valuable to design and problem-solving, and writer sufficiently integrates user experience in paper. There may be some confusion in terms of comprehension, but writer uses empathetic techniques, such as paraphrasing and mirroring in clear, useful ways.	The user experience is empathically accounted for in multiple ways; language integrates client-based experiences by using summary, paraphrase, and quotations to provide attribution to client, stakeholder and/or audience-related statements; audience needs are wholly integrated in problem-solving design.

III. Results and major findings

Since we have not collected data yet, we will provide a reflection on the so far status of the program and how the students are doing in terms of achieving the learning outcomes in the various courses.

IV. Closing the loop

Changes and modifications that are planned to achieve desired goals, including to achieve desired level of mastery in outcomes to be assessed in the future.

As data are collected from this first year, we will be able to benchmark the state of both the curriculum and student learning, and from there we will establish a plan with changes and modifications in the future to achieve desired goals.

Long term planning that the department is considering.

The department is considering long term planning in the areas of:

- Current course offerings and curriculum
- Graduate program offerings
- Future expansion of undergraduate program

Teams have been formed to evaluate next steps, while assessing the current state of the program.

Most important suggestions/feedback from the FDCD on the last assessment report, and how they were incorporated.

Since this is our first assessment report, we do not have feedback to address. We are looking forward to the FDCD’s suggestions and feedback on our first annual assessment report, to be addressed next year.