PennState

SENATE COMMITTEE ON CURRICULAR AFFAIRS

COURSE SUBMISSION AND CONSULTATION FORM

Principal Faculty Member(s) Proposing Course

Name	User ID	College	Department
VALERIE VANDERHOFF	vuv3	Nursing (NR)	Not Available
NATHANIEL BOHNA	nab141	Engineering (EN)	Not Available

Academic Home: University College (UC)

Type of Proposal: ☒ Add ☐ Change ☐ Drop

Course Designation

(ENGR 120N) Design Thinking and 3D Printing in Engineering and Healthcare

Course Information

Cross-Listed Courses:

Prerequisites:

No prerequisite

Corequisites:

Concurrents:

Recommended Preparations:

Abbreviated Title:	3D Design Thinking
Discipline:	General Education
Course Listing:	Inter-Domain

Special categories for Undergraduate (001-499) courses

Foundations

☐ **Writing/Speaking (GWS)**

☐ **Quantification (GQ)**

Knowledge Domains

☐ **Health & Wellness (GHW)**

☒ **Natural Sciences (GN)**

☒ **Arts (GA)**

☐ **Humanities (GH)**

☐ **Social and Behavioral Sciences (GS)**

Additional Designations

☐ **Bachelor of Arts**

☐ **International Cultures (IL)**

☐ **United States Cultures (US)**

☐ **Honors Course**

☐ **Common course number - x94, x95, x96, x97, x99**

☐ **Writing Across the Curriculum**

First-Year Engagement Program

☐ **First-Year Seminar**

Miscellaneous

☐ **Common Course**

GE Learning Objectives

☐ **GenEd Learning Objective: Effective Communication**
☒ **GenEd Learning Objective: Creative Thinking**
☐ **GenEd Learning Objective: Crit & Analytical Think**
☐ **GenEd Learning Objective: Global Learning**
☒ **GenEd Learning Objective: Integrative Thinking**
☒ **GenEd Learning Objective: Key Literacies**
☒ **GenEd Learning Objective: Soc Resp & Ethic Reason**

Bulletin Listing

Minimum Credits:	3
Maximum Credits:	3
Repeatable:	NO
Department with Curricular Responsibility:	UC Engineering (UC_UCENG)
Effective Semester:	FA 2018
Travel Component:	NO

Course Outline

A brief outline or overview of the course content:
Design Thinking and 3D Printing in Engineering and Healthcare (ENGR 120N) is an introductory course allowing students to explore concepts in Design Thinking, science, and technology through team-based and individual studio work in the development of 3D applications.

A listing of the major topics to be covered with an approximate length of time allotted for their discussion:
Design thinking, Problem-solving processes, Engineering , 3D production process (8 weeks)
Anatomy, Healthcare, healthcare applications, Microprinting process, ethical/legal/financial considerations (7 weeks)

Course Description:
Design Thinking and 3D Printing in Engineering and Healthcare (ENGR 120N) is an introductory general education interdomain course. The course will introduce basic concepts of design processes, engineering, and medicine. The course will assist students in realizing the power of creativity and imagination as it is applied to the use of emerging technologies to solve design dilemmas at the local, regional, national, and international levels.

Students will be encouraged to secure an interdisciplinary and collaborative foundation through an exploration of topics including basic engineering, human anatomy and health, design (proportion, structure, integrity, design, scale, manufacturing, iteration), Design Thinking concepts (empathize, define, create, prototype, and test), problem-solving processes (brainstorming, free thought, think aloud, reverse engineering), 3D production processes, Bioprinting (use of biofilm to create human tissue and organs), Engineering, Medicine, and Microprinting (creating works of art from photos taken from microscope slides). Students will be encouraged to view projects from the User/Patient perspective.

Promotion of integrative thinking will be encouraged throughout the coursework with the goal of increasing the incorporation of design, problem-solving, engineering and medicine in the disciplines of study for individual students. Integrative thinking will be assessed through student involvement in online discussions, case studies, class conversations encompassing ethical/legal/financial considerations to design issues, studio time, image production and manipulation, internet file sharing, materials/properties selection, production processes, and interdisciplinary individual and team-based projects encompassing creative expression and science.

By the end of the course, students will be furnished with basic knowledge and strategies to evaluate the role of design in the world and to independently act on the information.

This course will fulfill 3 credits of the General Education requirements addressing the interdomain fields of Art (GA) and Natural Sciences (GN).
No prerequisites are required for the course. This course will serve as an introduction to the basic ideas of design, creativity, imagination and problem-solving to complement development in science disciplines across the university community.

The name(s) of the faculty member(s) responsible for the development of the course:

- Name: NATHANIEL BOHNA (nab141)

Title: Associate Teaching Professor of Engineering
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Address: 2201 University Drive
Campus: FE

City: Lemont Furntace
Fax:

Name: VALERIE VANDERHOFF (vuv3)
Title: Assistant Teaching Professor, College of Nursing
Phone: 7244304188
Address: 2201 University Drive
Campus: FE
City: Lemont Furntace
Fax:

Course Justification

Instructional, Educational, and Course Objectives:
This section should define what the student is expected to learn and what skills the student will develop.
1.GA1. Explain the methods of inquiry in arts fields and describe how the contributions of these fields complement inquiry in other areas.
-Students will be able to demonstrate the creative process through preparation, incubation, illumination/insight, evaluation, and implementation of 3D printed projects.
-Students will be able to synthesis knowledge of art field and scientific inquiry across disciplines through 3D printed projects, classroom and on-line discussions and portfolio/journal reflections.
-Students will be able to demonstrate development of information gathering skills; creation of ideas/brainstorming; prototype creation and modification; Design Thinking application; peer evaluation; and verbal, written, and physical presentation of ideas through 3D printed designs and discussions.
2. GA2. Demonstrate an expanded knowledge and comprehension of the role that the arts play in various aspects of human endeavor.
-Students will be able to evaluate the merits
of selected designs related to physical space, purpose, aesthetics, and cost-effectiveness and the influences surrounding these areas as evidenced through classroom and online discussions.
-Students will be able to implement multiple influences into their original designs as evidenced by 3D printed projects and portfolio/journal entries.
-Students will be able to implement design improvements based on influences of users/peer feedback as evidenced by 3D printed projects and portfolio/journal entries.
3. GA3. Demonstrate competence in the creation of works of art and design.
-Students will be able to demonstrate proficient skills in creative process and Design Thinking in project generation as evidenced through 3D projects.
4. GN1. Explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas.
-Students will be able to practice the process of research and Evidence-Based Practice (EBP) in fields of science (biology, chemistry, anatomy) as it applies to healthcare and engineering as evidenced by classroom and online discussions and case studies.
-Students will be able to implement gathered knowledge of research and EBP across multiple disciplines as evidenced by 3D printed projects, classroom and on-line discussions, case studies, and portfolio/journal entries.
-Students will develop skills in comparison; inquiry; and interdisciplinary application of ideas as evidenced by classroom and on-line discussions, case studies, and portfolio/journal entries.
5. GN3. Demonstrate informed understandings of scientific claims and their applications.
-Students will be able to interpret, evaluate, and implement knowledge regarding scientific claims as evidenced by classroom and on-line discussions, case studies, and portfolio/journal entries.
-Students will develop skills in information gathering; analysis of information; prototype creation and modification; Design Thinking application; peer evaluation; and verbal, written, and physical
presentation of ideas as evidenced by 3D printed projects, classroom and on-line discussions, case studies, and portfolio/journal entries.
6. GN5. Identify societal or philosophical implications of discoveries in the natural sciences, as well as their potential to address contemporary problems.
-Students will explore social influences and how they apply to healthcare and engineering problems as evidenced by classroom and on-line discussions, case studies, and portfolio/journal entries.
-Students will develop skills in intellectual debate, professional courtesy, information gathering, data analysis, and empathic interaction as evidenced by classroom and on-line discussions, case studies, and portfolio/journal entries.

Evaluation Methods:
Include a statement that explains how the achievement of the educational objective identified above will be assessed. The procedures for determining students' grades should be specifically identified.
1. GA1. Explain the methods of inquiry in arts fields and describe how the contributions of these fields complement inquiry in other areas.
Students will be evaluated in these areas by:
-Online discussion Boards examining each area of the creative process (rubric will be provided).
-Classroom discussions will explore how creative process can influence areas outside of art. (involvement in discussions will contribute to Class participation grade).
-Design Projects/3D creations/Microprints will physically reflect students progress through creative process (rubric will be provided).
-Portfolio/Journal entries will follow students cognitive and psychomotor progress through creative process and self-reflection (rubric will be provided).
2. GA2. Demonstrate an expanded knowledge and comprehension of the role that the arts play in various aspects of human endeavor.

-Online discussion Boards examining several aspects of artistic influence and human inquiry (rubric will be provided).
-Classroom discussions will explore how aspects of artistic influence and human inquiry have the ability to drive research, development, and commerce (involvement in discussions will contribute to Class participation grade).
-Design Projects/3D creations/Microprints will demonstrate students integration of creative process and design thinking/human involvement (rubric will be provided).
-Portfolio/Journal entries will follow students cognitive and psychomotor progress through the creative process, design thinking and self-reflection (rubric will be provided).
-Case Studies will provide students with the ability to inquire about the role of design creativity in various disciplines. Students will compare/contrast various influencing factors to situations. (Students will be evaluated on the ability to provide multiple viewpoints and to inquire beyond the written information).
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3. GA3. Demonstrate competence in the creation of works of art and design.
-Design Projects/3D creations/Microprints will demonstrate students integration of creative process and design thinking/human involvement (rubric will be provided).
-Portfolio/Journal entries will follow students cognitive and psychomotor progress through the creative process, design thinking and self-reflection (rubric will be provided).

4. GN1. Explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas.
-Midterm Group Assignment: Students will evaluate the merits of selected designs related to physical space, purpose, aesthetics, and cost-effectiveness. Students will explore options for improvement of identified areas of deficiency. Students will work as a team to develop modifications based on research to an object or set of objects that reflect a theme (ie: game pieces, puzzle pieces, wall displays). Members of the team will be assigned individual components to design. The team will be responsible for maintaining cohesive group design, scaling, and theme. (Group and individual participation rubric will be provided).
-Design Projects/3D creations/Microprints will demonstrate students integration of creative process and design thinking/human involvement (rubric will be provided)
5. GN3. Demonstrate informed understandings of scientific claims and their applications.
-Portfolio/Journal entries will follow students cognitive and psychomotor progress through the evaluation of design and application of research/EBP (rubric will be provided).
-Case Studies will provide students with the ability to inquire about the role of design creativity in various disciplines. Students will compare/contrast various influencing factors to situations. (Students will be evaluated on the ability to provide multiple viewpoints and to inquire beyond the written information).
-Design Projects/3D creations/Microprints will demonstrate students integration as they examine the applications of 3D printing in engineering and/or biomedical technology. Students can scan or use 3D online file to create functional engineering/biomedicals devices.
6. GN5. Identify societal or philosophical implications of discoveries in the natural sciences, as well as their potential to address contemporary problems.
-Students will explore through class discussions/debates, journaling, and online discussion boards financial, insurance, distribution, and ethical considerations in the 3D printing. Rubrics will be provided for debates, journaling, and discussion boards.

Overall grade allotments:
Attendance/participation/studio time (15 wks-4 pts each) 60 (20%)
3D projects design & printing (4 projects-10 pts each) 40 (13%)
Microscope art design & printing 25 (8%)
Midterm Group Project 25 (8%)
Design Portfolio (art & journal. 7 entries-5 pts each) 35 (12%)
Case Studies (3-15 points each) 45 (15%)
Online Discussion Board (7 postings-5pts each) 35 (12%)
Final-Art show submission 35 (12%)

Relationship/Linkage of Course to Other Courses:
This statement should relate the course to existing or proposed new courses. It should provide a rationale for the level of instruction, for any prerequisites that may be specified, or for the course's role as a prerequisite for other courses.
This course is not directly linked to any other Penn State courses. It does, however, share overlapping topics of Health and Wellness, Engineering, and Healthcare with introductory level EDSGN, ENGR, and NURS courses. This course seeks to combine aspects of science and technology with topics that are relevant to modern society (such as gun control, biomedical printing, and housing).

Relationship of Course to Major, Option, Minor, or General Education:
This statement should explain how the course will contribute to the major, option, or minor and indicate how it may function as a service course for other departments.
This course will fulfill General education Interdomain requirements, incorporating GA and GN objectives. This course is not required for any minor or major. This course does not require, nor is, a pre-requisite for any other course.

A description of any special facilities:
This course will require access to 3D printers. This could be accomplished with 3D printing accessibility on-campus or within the community. 3D printing also requires accessibility to 3D printing media/fillament (such as commonly available PLA filament). 3D scanning will require access to a suitable 3D scanning device and also a computer capable of rendering the 3D scanned image.

Frequency of Offering and Enrollment:
This course has the potential to be offered every semester with enrollment capped at 24 students. The class limit is determined by the number of computers and also the number of 3D printers available to the students.

Alignment with General Education Objectives

☐ **EFFECTIVE COMMUNICATION – the ability to exchange information and ideas in oral, written, and visual form in ways that allow for informed and persuasive discourse that builds trust and respect among those engaged in that exchange, and helps create environments where creative ideas and problem-solving flourish.**

☒ **KEY LITERACIES – the ability to identify, interpret, create, communicate and compute using materials in a variety of media and contexts. Literacy acquired in multiple areas, such as textual, quantitative, information/technology, health, intercultural, historical, aesthetic, linguistic (world languages), and scientific, enables individuals to achieve their goals, to develop their knowledge and potential, to lead healthy and productive lives, and to participate fully in their community and wider society.**

☐ **CRITICAL AND ANALYTICAL THINKING – the habit of mind characterized by comprehensive exploration of issues, ideas, artifacts, and events before accepting or formulating a conclusion. It is the intellectually disciplined process of conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action.**

☒ **INTEGRATIVE THINKING – the ability to synthesize knowledge across multiple domains, modes of inquiry, historical periods, and perspectives, as well as the ability to identify linkages between existing knowledge and new information. Individuals who engage in integrative thinking are able to transfer knowledge within and beyond their current contexts.**

☒ **CREATIVE THINKING – the capacity to synthesize existing ideas, images, or expertise in original ways and the experience of performing, making, thinking, or acting in an imaginative way that may be characterized by innovation, divergent thinking, and intellectual risk taking.**

☐ **GLOBAL LEARNING – the intellectually disciplined abilities to analyze similarities and differences among cultures; evaluate natural, physical, social, cultural, historical, and economic legacies and hierarchies; and engage as community members and leaders who will continue to deal with the intricacies of an ever-changing world. Individuals should acquire the ability to analyze power; identify and critique interdependent global, regional, and local cultures and systems; and evaluate the implications for people's lives.**

☒ **SOCIAL RESPONSIBILITY AND ETHICAL REASONING – the ability to assess one's own values within the social context of problems, recognize ethical issues in a variety of settings, describe how different perspectives might be applied to ethical dilemmas, and consider the ramifications of alternative actions. Individuals should acquire the self-- knowledge and leadership skills needed to play a role in creating and maintaining healthy, civil, safe, and thriving communities.**

What component(s) of the course will help students acheive the General Education Learning Objectives covered in the course? Provide evidence that students in the course have adequate opportunities to achieve the identified learning objectives.

Key Literacies: Students will have the opportunity become familiar with Design Thinking process, Creative processes, Problem-solving processes, Engineering, Basic Human Anatomy, 3D printing, and Microprinting. Students will have the opportunity to use knowledge to direct personal and community choices.

Integrative thinking: Students will have the opportunity to create an original design incorporating basic concepts of Design Thinking, 3D printing/Microprinting and Engineering and Healthcare.
-Students will create a design portfolio that will demonstrate their journey from basic design to original creations encompassing 3D printing process (pre- and post-production, transportation, defense weapons, jewelry), healthcare impact (stents, prosthetics, casts, bioprinting), Design Thinking (empathize, define, ideate, prototype and test).
-Students will have the opportunity to create 3D medical models and use Design Thinking process visualize healthcare applications for a functional purpose (anatomical models used for educational and surgical research purposes).
-Students will examine how the aesthetics of a design can enhance the functionality of an object (user/patient by-in). They will research ways in which biomedical devices are designed based on patient emotional, spiritual, environmental, physical, social, intellectual, and occupational influences. Students will be tasked with designing a 3D project taking patient influences into consideration.
-Students will participate in online discussion boards which explore fundamental concepts of biomedical applications of 3D printing.

Creative process/thinking:
-Students will apply artistic process and design thinking process to 3D scanning/printing and microprinting.
-Students will work in teams to create various pieces of art that will collectively reflect a uniform theme. For example, they can work as a team to develop a puzzle or game that reflects an overall theme.

Social responsibility and ethical reasoning:
-Students will explore social and ethical considerations related to 3D printing (health risks, environmental bi-products of 3D printing, distribution of resources, etc) via case studies.
-Students will have the opportunity to explore the social and ethical implications of patent and copyrights, organ procurement, cost-effectiveness, insurance claims, quality/quantity of life debate, 3d printer lab and resource availability, 3D environmental impact/OSHA, 3D printing waste disbursement (recycling potential), fair distribution of knowledge (3D locations in educational and public locations) via class debates, online discussions, journaling and case studies.

How will students be assessed to determine their attainment of the Learning Objective(s) of General Education covered in this course? This assessment must be included as a portion of the student's overall performance in this course.

Key Literacies:
-Students will choose and print a 3D design project. Students will be responsible to evaluate cost-effective materials, design options, and manufacturing needs.
-Students will develop a revised design of an everyday device using Design Thinking process and analyze the effective functionality for the end-user/patient. Students will suggest small modifications to improve functionality (for example, make it more functional, ergonomic, economical to manufacture, or visually appealing).
-Students will evaluate and select a 3D medical application for printing, evaluate cost, aesthetic appeal, and functionality for target populations using Design Thinking process and analyze the effective functionality of end-user/patient.
-Students will participate in online discussions related to engineering and biomedical applications in 3D printing. They will evaluate the evidence-based research merits of a particular 3D printed device or application and discuss with their peers. Each discussion will focus on a current topic and students will be directed to read a relevant online article. They will be graded based on the number of interactions in each discussion and also on the quality/length of those discussions.

Integrative thinking:
-Students will create 3D models which will reflect medical models. These models will integrate knowledge from engineering and healthcare domains in order to illustrate biomedical devices/processes which are accurate, functioning, and utilize Design Thinking. Their 3D-printed model will be graded using rubrics based on the accuracy, functionality, and adaptations of emotional, spiritual, environmental, physical, social, intellectual, and occupational impacts of the end-user.
-Students will research different ways Design Thinking (empathize, define, create, prototype, and test) can change the function of a design based on intended use (engineering, healthcare). Students will be evaluated online (discussion boards) regarding their understanding of concepts.

Creative thinking:
-Students will use 3D scanning to create a 3D drawing of an existing object. This can, for example, be part of the body (like a person's face) or an everyday object (like a cell phone). They will use this 3D drawing to create an original creative piece which incorporates 2 or more 3D drawing files (for example, students may put their 3D-scanned face onto a 3D model of a Greek statue that is a bobblehead). They will be graded based on their ability to accurately scan the original object and their ability to successfully blend 3D-scanned objects with a separate 3D drawing to create a single unique object which incorporates all initial drawing files.
-Students will work in teams to create a completely unique 3D printed object or set of objects (For example, a set of chess pieces, puzzle pieces, wall art displays) that reflect an overall theme. They will be graded based on rubrics based on their ability to function well as a team to produce a 3D-printed prototype.
-Students will create a microprint (photo from microscope slide) and use a photo editing tool to customize artwork. Students will have the opportunity to work with biology faculty to design artwork for campus departments. Microprint will be converted to 3D printed plates.
-Students will showcase original 3D-printed projects at an end-of-semester Learning Fair. They will be graded based on project feedback/design improvement integration.

Social Responsibility and Ethical Reasoning
-Students will explore ethical considerations related to 3D printing (health risks, environmental bi-products of 3D printing, etc) via case studies, online discussion boards, and classroom conversations. Students will be graded based on their use of class content and critical and analytical thinking skills to contribute to the overall body of knowledge. Grading will be done with rubrics for each area of involvement.
-Students will choose a project theme from a list of suggested topics pertaining to biomedical applications of 3D printing and participate in debates. Examples can include topics such as organ procurement, insurance claims, quality/quantity of life debates surrounding 3D bio-printing, 3D-printing waste disbursement, environmental/safety hazards of 3D printing, etc.. Students will be graded, based on rubrics, on their ability to present data in a clear and logical manner.

General Education Domain Criteria

General Education Designation: Inter-Domain

GA Criteria

☒ **Explain the methods of inquiry in arts fields and describe how the contributions of these fields complement inquiry in other areas**

☒ **Demonstrate an expanded knowledge and comprehension of the role that the arts play in various aspects of human endeavor**

☒ **Demonstrate competence in the creation of works of art and design**

☐ **Demonstrate competence in analysis, critical thinking and interpretive reasoning through the exploration of creative works**

☐ **Identify and explain the aesthetic, historic, social, and cultural significance of important works of art and critically assess creative works, their own or others', through evaluative processes of analysis and interpretation**

What components of the course will help students acheive the domain criteria selected above?

Explain the methods of inquiry in the art fields and describe how the contributions of
these fields complement inquiry in other areas:
Students will examine design thinking and creative processes through group classroom activities. During these activities, students will examine how the needs of the user can influence the creative process. Students will be tasked with questioning the intended use of a design and then examine how the user needs to affect the design process. They will be required to produce a design that fulfills the need of the user, is aesthetically pleasing, functional, and scientifically sound. They will examine the way in which decisions about functionality can affect aesthetics and vice versa.
Demonstrate an expanded knowledge and comprehension of the role that the arts play in various aspects of human endeavor:
Students will participate in online discussions about design thinking and the applications of 3D printing and design thinking to topics such as art, jewelry, housing, and healthcare. Students will explore ways in which design thinking and 3D printing impact these areas and the ways in which functionality meets aesthetics.
Demonstrate competence in the creation of works of art and design:
Students will use 3D CAD software (TinkerCAD, Solidworks, Blender, Mudbox, etc.) to create and print unique 3D objects. Students will explore the creation of new works of art through combining multiple existing files into new 3D creations. Students will use virtual reality (VR) to create an original object, save the VR file, modify it using software if desired and then 3D print their work. This process allows for rapid prototyping of real-world designs that students can see and manipulate prior to actual fabrication. Students will address finishing processes (paint, sand, cleaning of 3D objects) of their designs and how they can modify processes for future applications. Students will be required to showcase selected original works of art from the course in a final art show which will be incorporated into the campus-wide learning fair at the end of the semester.

GN Criteria

☒ **Explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas**

☐ **Construct evidence-based explanations of natural phenomena**

☒ **Demonstrate informed understandings of scientific claims and their applications**

☐ **Evaluate the quality of the data, methods, and inferences used to generate scientific knowledge**

☒ **Identify societal or philosophical implications of discoveries in the natural sciences, as well as their potential to address contemporary problems**

What components of the course will help students acheive the domain criteria selected above?

Explain the methods of inquiry in the natural science fields and describe how the contributions of these fields complement inquiry in other areas:
Students will apply the design thinking process that they learned in class activities to the completion of a midterm group project. Each group (consisting of 4-5 students) will produce a prototype of an original 3D design that has an application to a scientific and/or biomedical field. Through completion of the midterm project, they will research a particular application and identify a problem and/or need for 3D printing which can solve the given problem. They will then provide an explanation of their project and show evidence of scientific inquiry to the rest of the class via an oral presentation. Examples could include topics such as models of 3D-printed splints, casts, prosthetics, organs, etc.
Demonstrate informed understandings of scientific claims and their applications
Students will participate in weekly discussion boards in which they will explore scholarly articles related to 3D printing and biomedical applications. Students will demonstrate an understanding of how many scientific uses of 3D printing in the healthcare and biomedical fields can be affected by aesthetic and artistic aspects of the design. Topics will include areas such as: design thinking, history of 3D printing, evidence-based-practice of 3D printing in healthcare, 3D-printing houses, applications of 3D-printing in dentistry, applications of 3D-printing in veterinary science, etc. For each discussion, students will be required to either read a current article or watch a video. They will then post one original comment or thought about something that they learned, and also comment on at least two other threads from other students in the class.
Identify societal or philosophical implications of discoveries in the natural sciences, as well as their potential to address contemporary problems
Students will be required to complete three case studies throughout the semester. For each case study, students will be required to identify an application of 3D-printing in society and answer the following questions: How does the technology impact the population? How does it impact finances/workforce? How can the technology be utilized where you live? Where do you see this technology progressing in the future? Students are required to support their responses with scholarly articles.

Integrative Studies

Explain how the intellectual frameworks And methodologies of the two Knowledge Domains will be explicitly addressed in the course and practiced by the students.

Medical technology evolution is projected to grow at a rate of 18% annually (Grunewald, 2016). Given the potential for economic and professional growth, it is imperative for today's workforce to be, at a minimum, adept at addressing key points in this field. Penn State has embraced this philosophy through their Strategic Plan to drive digital innovation and enhancing health. Through the empowerment of the Strategic Plan, students will be fostering and embracing a diverse world. By offering coursework in new technologies, applications, and discovery, PSU continues to strive to engage our students and enable access to a growing global community.
Students who decide to explore and embrace the creative process needed to implement quality engineering and medical 3D printed projects will place themselves ahead of their peers in the current competitive workplace. Students will have the opportunity to reflect on personal viewpoints and ethical dilemmas in a safe environment through journaling in design portfolios. Class discussions, online discussions, case studies, and presentations will aid the student in this process. Students will be given the opportunity to develop an appreciation of areas that may not be in their field of study and the roles that novice designers play across the domains of engineering and healthcare.
Students will learn about scientific achievements that are made possible with 3D printing/digital art and also how those scientific achievements must also be visually and aesthetically appealing to the user for maximum implementation. They will examine the relationship between Design Thinking, creative process, and scientific application to discuss and explore areas in which form can enhance the function of an object. Students will apply the five stages of design thinking (empathise, Define, Ideate, Prototype, Test) to problems with scientific relevance. They will seek to empathize with the user (patient) to understand their needs (emotional, spiritual, environmental, physical, social, intellectual, and occupational), define a problem in biomedicine/healthcare, ideate solutions, 3D-print prototypes, and test their design.

Demonstrate that each Of the two domains will receive approximately equal attention, providing evidence from course topics, assignments, or other course components, and that students will integrate material from both domains.

For the GA Domain:
Approximately 7 weeks of instruction in basic Design Thinking, creativity, imagination, problem-solving processes, microprinting, and 3D printing as an artistic application (history, process, devices) as it relates to current research topics and societal needs, housing, food production, aesthetics (jewelry, art).
For the GN Domain:
Approximately 8 weeks of instruction in basic engineering concepts, anatomy, healthcare, bioprinting, Design Thinking integration into the science fields, and 3D printing as it relates to current research topics in engineering and medicine.
Students will also use drawings, online 3D files, CAD design, and studio time to create original 3D projects.
Students will have the availability to learn and complete the process of 3D printing using the 3D printers on this campus. It is understood that not all campuses have access, nor wish to grant students access, to 3D printers.

Briefly explain the staffing plan. Given that each Inter-Domain course is approved for two Knowledge Domains, it will be taught by an instructor (or instructional team) with appropriate expertise in both domains.

Instructor(s) for ENGR 120N should have a basic knowledge of design and/or 3D experience, health and wellness/biomedical background, and Design Thinking. Instructor(s) should be able to discuss 3D design components, engineering and biomedical

applications, and ethical/social impacts of the topic. Instructors will benefit from consulting with faculty in areas outside of personal expertise.
Nathaniel Bohna, PhD, is the Campus Program Coordinator for Science and Engineering at Fayette, The Eberly Campus and is an Associate Teaching Professor of Engineering. He has been teaching 3D design and application for 4 years. Under his direction, the 3D print lab at Fayette currently has 6 functioning 3D printers and 2 scanners with studio time available to students 10 hours day/5 days a week.
Valerie Vanderhoff, DNP, is an Assistant Teaching Professor of Nursing at Fayette, The Eberly Campus. She has been a nursing instructor for 10 years (all levels of instruction), has established and managed multiple simulation labs, has experience in graphic design/layout, and has been a proponent of advancing new technologies throughout her career. Valerie has taken part in Stanford University's Design Thinking training.

Describe the assessments that will be used to determine students' ability to apply integrative thinking.

To evaluate students' developmental process, instructors will use 3D printed projects, class participation and problem-solving, group assignments and evaluation of team function, class debates, journaling of design portfolio, online exam/discussion boards, and case studies. All projects will be evaluated using various established Penn State Schreyer Institute for Teaching Excellence rubrics. Students will be assessed on their ability to integrate Design Thinking, creative process, engineering, healthcare, and technology.

Campuses That Have Offered ( ) Over The Past 4 Years

semester	AB	AL	BK	BR	BW	CR	DS	ER	FE	GA	GV	HB	HN	HY	LV	MA	NK	PC	SH	SL	UP	WB	WC	WS	XC	XP	XS	YK

UPLOADED DOCUMENTS FOLLOW:

TEAMWORK VALUE RUBRIC

for more information, please contact value@aacu.org

The VALUE rubrics were developed by teams of faculty experts representing colleges and universities across the United States through a process that examined many existing campus rubrics and related documents for each learning outcome and incorporated additional feedback from faculty. The rubrics articulate fundamental criteria for each learning outcome, with performance descriptors demonstrating progressively more sophisticated levels of attainment. The rubrics are intended for institutional-level use in evaluating and discussing student learning, not for grading. The core expectations articulated in all 15 of the VALUE rubrics can and should be translated into the language of individual campuses, disciplines, and even courses. The utility of the VALUE rubrics is to position learning at all undergraduate levels within a basic framework of expectations such that evidence of learning can by shared nationally through a common dialog and understanding of student success.

Definition

Teamwork is behaviors under the control of individual team members (effort they put into team tasks, their manner of interacting with others on team, and the quantity and quality of contributions they make to team discussions.)

Framing Language

Students participate on many different teams, in many different settings. For example, a given student may work on separate teams to complete a lab assignment, give an oral presentation, or complete a community service project. Furthermore, the people the student works with are likely to be different in each of these different teams. As a result, it is assumed that a work sample or collection of work that demonstrates a student's teamwork skills could include a diverse range of inputs. This rubric is designed to function across all of these different settings.

Two characteristics define the ways in which this rubric is to be used. First, the rubric is meant to assess the teamwork of an individual student, not the team as a whole. Therefore, it is possible for a student to receive high ratings, even if the team as a whole is rather flawed. Similarly, a student could receive low ratings, even if the team as a whole works fairly well. Second, this rubric is designed to measure the quality of a **process**, rather than the quality of an **end product**. As a result, work samples or collections of work will need to include some evidence of the individual's interactions within the team. The final product of the team's work (e.g., a written lab report) is insufficient, as it does not provide insight into the functioning of the team.

It is recommended that work samples or collections of work for this outcome come from one (or more) of the following three sources: (1) students' own reflections about their contribution to a team's functioning; (2) evaluation or feedback from fellow team members about students' contribution to the team's functioning; or (3) the evaluation of an outside observer regarding students' contributions to a team's functioning. These three sources differ considerably in the resource demands they place on an institution. It is recommended that institutions using this rubric consider carefully the resources they are able to allocate to the assessment of teamwork and choose a means of compiling work samples or collections of work that best suits their priorities, needs, and abilities.

TEAMWORK VALUE RUBRIC

for more information, please contact value@aacu.org

Association of American Colleges and Universities

Definition

Teamwork is behaviors under the control of individual team members (effort they put into team tasks, their manner of interacting with others on team, and the quantity and quality of contributions they make to team discussions.)

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone 4	**Milestones** 3	 2	**Benchmark** 1
Contributes to Team Meetings	Helps the team move forward by articulating the merits of alternative ideas or proposals.	Offers alternative solutions or courses of action that build on the ideas of others.	Offers new suggestions to advance the work of the group.	Shares ideas but does not advance the work of the group.
Facilitates the Contributions of Team Members	Engages team members in ways that facilitate their contributions to meetings by both constructively building upon or synthesizing the contributions of others as well as noticing when someone is not participating and inviting them to engage.	Engages team members in ways that facilitate their contributions to meetings by constructively building upon or synthesizing the contributions of others.	Engages team members in ways that facilitate their contributions to meetings by restating the views of other team members and/or asking questions for clarification.	Engages team members by taking turns and listening to others without interrupting.
Individual Contributions Outside of Team Meetings	Completes all assigned tasks by deadline; work accomplished is thorough, comprehensive, and advances the project. Proactively helps other team members complete their assigned tasks to a similar level of excellence.	Completes all assigned tasks by deadline; work accomplished is thorough, comprehensive, and advances the project.	Completes all assigned tasks by deadline; work accomplished advances the project.	Completes all assigned tasks by deadline.
Fosters Constructive Team Climate	Supports a constructive team climate by doing all of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any three of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any two of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any one of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.
Responds to Conflict	Addresses destructive conflict directly and constructively, helping to manage/resolve it in a way that strengthens overall team cohesiveness and future effectiveness.	Identifies and acknowledges conflict and stays engaged with it.	Redirecting focus toward common ground, toward task at hand (away from conflict).	Passively accepts alternate viewpoints/ideas/opinions.

Work with Other Teams Rubric

Weight	Criteria	Exemplary (3)	Competent (2)	Developing (1)	"Voted off the Island" (0)	Score	Comments
Responsible Team Member							
	Contributes to project	Contributes to project, **Helps other team members to contribute more effectively.**	Contributes to project	Contributes but not regularly	Does not contribute	____	
	Completes project component(s) assigned by group	Completes project component(s) assigned by group. **Answers inquiries about other member's work.**	Completes project component(s) assigned by group	Project work complete but inaccurate or not as assigned	Project work is not complete	____	
	Perceives project responsibility as own	Perceives project responsibility as own. **Helps other team members understand their responsibilities.**	Perceives project responsibility as own	Not consistently responsible	Not responsible	____	
	Is respectful of other team members	Always respectful of other team members. **Sets example for other team members**	Is respectful of other team members	Sometimes is rude or ignores other team members	Rude or ignores other team members	____	
	Attends every meeting	Attends every meeting**. Provides flexibility and available when asked.**	Attends every meeting	Attends some meetings	Does not attend meetings	____	
Group Facilitation							
	Ensures group stays on track/meets deadlines	Ensures group stays on track/meets deadlines. **When not on track suggest reasonable alternatives.**	Ensures group stays on track/meets deadlines	Cannot always identify group progress, does not always meet group deadlines	Cannot identify group progress, is late with assignments	____	
	Able to divide work responsibilities among group members	Divides work responsibilities among group members. **Helps to resolve potential conflicts regarding responsibilities.**	Divides work responsibilities among group members	Seldom helps to divide work responsibilities among group members	Does NOT help to divide work responsibilities among group members	____	
	Able to solve group problems	Able to solve group problems. **Makes suggestions for improvement.**	Solves group problems	Not always able to solve group problems	Cannot solve group problems	____	
	Assists in group decisions	**Facilitates** group decisions.	Assists in group decisions	Seldom assists in group decisions	Does not assist in group decisions	____	
	Can articulate the "end product" to other team members	Can articulate the "end product" to other team members. **Ensures other team members can articulate "end product"**.	Articulates the "end product" to other team members	Can articulate the "end product" to other team members	Can articulate the "end product" to other team members	____	
	Reviews work of other team members	Reviews work of other team members, **Able to provide solutions to improve.**	Reviews work of other team members	Seldom reviews work of other team members especially when asked	Does NOT review anyone's work	____	
	Able to articulate how each team member's component(s) contribute to whole project	Able to articulate how each team member's component(s) contribute to whole project, **Helps other group members to do the same.**	Able to articulate how each team member's component(s) contribute to whole project	Able to articulate how some of the team member's component(s) contribute to whole project	Cannot articulate how each team member's component(s) contribute to whole project	____	
	Able to critique draft(s) of project	Critiques draft(s) of project. **Provides helpful suggestions for improvement.**	Able to critique draft of project	Able to analyze some of the draft(s) of project.	Cannot critique draft(s) of project.	____	

Work with Other Teams Rubric

Weight	Criteria	Exemplary (3)	Competent (2)	Developing (1)	"Voted off the Island" (0)	Score	Comments
Communication							
	Able to communicate effectively with other team members	Communicate effectively with other team members, **Provides additional communications to other team member when needed.**	Communicates effectively with other team members	Sometimes communicates effectively with other team members	Does not communicate effectively with other team members	____	
	Responds to correspondence in a timely manner	Responds to correspondence in a timely manner. **Ensures all members are responding to inquiries.**	Responds to correspondence in a timely manner	Responds to correspondence but not in a timely manner	Does not respond to correspondence	____	
Content/Knowledge Skills							
	Understands his/her component of project	Understands his/her component of project. **Helps with understanding.**	Understands his/her component of project	Somewhat understands his/her component of project.	Does not understands his/her component	____	
	Understands each component of project	Understands each component of project. **Helps with understanding.**	Understands each component of project	Somewhat understands each component of project	Does not understands the other components	____	
	Understands how components fit together; gets the "big picture"	Understands how components fit together; gets the "big picture". **Helps with understanding.**	Understands how components fit together; gets the "big picture"	Somewhat understands how components fit together	Does not understands how components fit together, Does not get the "big picture"	____	
	Provides helpful feedback to improve project	Provides helpful feedback to improve project. **Ensures feedback is being acted upon.**	Provides helpful feedback to improve project	Provides feedback but it is not always helpful to improve project	Provides helpful feedback to improve project	____	
	Can answer questions about other team member component(s)	Can answer questions about other team member component(s). **Proactively seeks understanding of group.**	Can answer questions about other team member component(s)	Can answer some but not all questions about other team member component(s)	Cannot answer questions about other team member component(s)	____	
	Has ability to complete all component(s) of project		Has ability to complete all component(s) of project	Has ability to complete some component(s) of project.	Does not have ability to complete the component(s) of the project.	____	
TOTAL						0	

Bold indicates "added" competency for rating level.

Integrative Learning VALUE Rubric

for more information, please contact value@aacu.org

Association of American Colleges and Universities

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Definition

Integrative learning is an understanding and a disposition that a student builds across the curriculum and co-curriculum, from making simple connections among ideas and experiences to synthesizing and transferring learning to new, complex situations within and beyond the campus.

Framing Language

Fostering students' abilities to integrate learning–across courses, over time, and between campus and community life–is one of the most important goals and challenges for higher education. Initially, students connect previous learning to new classroom learning. Later, significant knowledge within individual disciplines serves as the foundation, but integrative learning goes beyond academic boundaries. Indeed, integrative experiences often occur as learners address real-world problems, unscripted and sufficiently broad, to require multiple areas of knowledge and multiple modes of inquiry, offering multiple solutions and benefiting from multiple perspectives. Integrative learning also involves internal changes in the learner. These internal changes, which indicate growth as a confident, lifelong learner, include the ability to adapt one's intellectual skills, to contribute in a wide variety of situations, and to understand and develop individual purpose, values and ethics. Developing students' capacities for integrative learning is central to personal success, social responsibility, and civic engagement in today's global society. Students face a rapidly changing and increasingly connected world where integrative learning becomes not just a benefit...but a necessity.

Because integrative learning is about making connections, this learning may not be as evident in traditional academic artifacts such as research papers and academic projects unless the student, for example, is prompted to draw implications for practice. These connections often surface, however, in reflective work, self assessment, or creative endeavors of all kinds. Integrative assignments foster learning between courses or by connecting courses to experientially-based work. Work samples or collections of work that include such artifacts give evidence of integrative learning. Faculty are encouraged to look for evidence that the student connects the learning gained in classroom study to learning gained in real life situations that are related to other learning experiences, extra-curricular activities, or work. Through integrative learning, students pull together their entire experience inside and outside of the formal classroom; thus, artificial barriers between formal study and informal or tacit learning become permeable. Integrative learning, whatever the context or source, builds upon connecting both theory and practice toward a deepened understanding.

Assignments to foster such connections and understanding could include, for example, composition papers that focus on topics from biology, economics, or history; mathematics assignments that apply mathematical tools to important issues and require written analysis to explain the implications and limitations of the mathematical treatment, or art history presentations that demonstrate aesthetic connections between selected paintings and novels. In this regard, some majors (e.g., interdisciplinary majors or problem-based field studies) seem to inherently evoke characteristics of integrative learning and result in work samples or collections of work that significantly demonstrate this outcome. However, fields of study that require accumulation of extensive and high-consensus content knowledge (such as accounting, engineering, or chemistry) also involve the kinds of complex and integrative constructions (e.g., ethical dilemmas and social consciousness) that seem to be highlighted so extensively in self reflection in arts and humanities, but they may be embedded in individual performances and less evident. The key in the development of such work samples or collections of work will be in designing structures that include artifacts and reflective writing or feedback that support students' examination of their learning and give evidence that, as graduates, they will extend their integrative abilities into the challenges of personal, professional, and civic life.

Glossary

The definitions that follow were developed to clarify terms and concepts used in this rubric only.

- Academic knowledge: Disciplinary learning; learning from academic study, texts, etc.
- Content: The information conveyed in the work samples or collections of work.
- Contexts: Actual or simulated situations in which a student demonstrates learning outcomes. New and challenging contexts encourage students to stretch beyond their current frames of reference.
- Co-curriculum: A parallel component of the academic curriculum that is in addition to formal classroom (student government, community service, residence hall activities, student organizations, etc.).
- Experience: Learning that takes place in a setting outside of the formal classroom, such as workplace, service learning site, internship site or another.
- Form: The external frameworks in which information and evidence are presented, ranging from choices for particular work sample or collection of works (such as a research paper, PowerPoint, video recording, etc.) to choices in make-up of the eportfolio.
- Performance: A dynamic and sustained act that brings together knowing and doing (creating a painting, solving an experimental design problem, developing a public relations strategy for a business, etc.); performance makes learning observable.
- Reflection: A meta-cognitive act of examining a performance in order to explore its significance and consequences.
- Self Assessment: Describing, interpreting, and judging a performance based on stated or implied expectations followed by planning for further learning.

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Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone 4	**Milestones** 3	2	**Benchmark** 1
Connections to Experience *Connects relevant experience and academic knowledge*	Meaningfully **synthesizes** connections among experiences outside of the formal classroom (including life experiences and academic experiences such as internships and travel abroad) to **deepen understanding** of fields of study and to broaden own points of view.	Effectively **selects and develops** examples of life experiences, drawn from a variety of contexts (e.g., family life, artistic participation, civic involvement, work experience), to **illuminate** concepts/theories/frameworks of fields of study.	**Compares** life experiences and academic knowledge to infer differences, as well as similarities, and **acknowledge perspectives** other than own.	**Identifies** connections between life experiences and those academic texts and ideas **perceived as similar and related** to own interests.
Connections to Discipline *Sees (makes) connections across disciplines, perspectives*	Independently creates wholes out of multiple parts (synthesizes) or draws conclusions by combining examples, facts, or theories from more than one field of study or perspective.	Independently connects examples, facts, or theories from more than one field of study or perspective.	When prompted, connects examples, facts, or theories from more than one field of study or perspective.	When prompted, presents examples, facts, or theories from more than one field of study or perspective.
Transfer *Adapts and applies skills, abilities, theories, or methodologies gained in one situation to new situations*	Adapts and applies, independently, skills, abilities, theories, or methodologies gained in one situation to new situations **to solve difficult problems or explore complex issues in original ways.**	Adapts and applies skills, abilities, theories, or methodologies gained in one situation to new situations **to solve problems or explore issues.**	Uses skills, abilities, theories, or methodologies gained in one situation in a new situation **to contribute to understanding of problems or issues.**	Uses, in a basic way, skills, abilities, theories, or methodologies gained in one situation **in a new situation.**
Integrated Communication	Fulfills the assignment(s) by choosing a format, language, or graph (or other visual representation) **in ways that enhance meaning**, making clear the interdependence of language and meaning, thought, and expression.	Fulfills the assignment(s) by choosing a format, language, or graph (or other visual representation) **to explicitly connect content and form**, demonstrating awareness of purpose and audience.	Fulfills the assignment(s) by choosing a format, language, or graph (or other visual representation) that **connects in a basic way** what is being communicated (content) with how it is said (form).	Fulfills the assignment(s) (i.e. to produce an essay, a poster, a video, a PowerPoint presentation, etc.) **in an appropriate form**.
Reflection and Self-Assessment	Envisions a future self (and possibly	Evaluates changes in own learning	Articulates strengths and challenges	Describes own performances with

Demonstrates a developing sense of self as a learner, building on prior experiences to respond to new and challenging contexts (may be evident in self-assessment, reflective, or creative work)	makes plans that build on past experiences that have occurred across multiple and diverse contexts).	over time, recognizing complex contextual factors (e.g., works with ambiguity and risk, deals with frustration, considers ethical frameworks).	(within specific performances or events) to increase effectiveness in different contexts (through increased self-awareness).	general descriptors of success and failure.

Ethical Reasoning VALUE Rubric

for more information, please contact value@aacu.org

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Definition

Ethical Reasoning is reasoning about right and wrong human conduct. It requires students to be able to assess their own ethical values and the social context of problems, recognize ethical issues in a variety of settings, think about how different ethical perspectives might be applied to ethical dilemmas and consider the ramifications of alternative actions. Students' ethical self identity evolves as they practice ethical decision-making skills and learn how to describe and analyze positions on ethical issues.

Framing Language

This rubric is intended to help faculty evaluate work samples and collections of work that demonstrate student learning about ethics. Although the goal of a liberal education should be to help students turn what they've learned in the classroom into action, pragmatically it would be difficult, if not impossible, to judge whether or not students would act ethically when faced with real ethical situations. What can be evaluated using a rubric is whether students have the intellectual tools to make ethical choices.

The rubric focuses on five elements: Ethical Self Awareness, Ethical Issue Recognition, Understanding Different Ethical Perspectives/Concepts, Application of Ethical Principles, and Evaluation of Different Ethical Perspectives/Concepts. Students' Ethical Self Identity evolves as they practice ethical decision-making skills and learn how to describe and analyze positions on ethical issues. Presumably, they will choose ethical actions when faced with ethical issues.

Glossary

The definitions that follow were developed to clarify terms and concepts used in this rubric only.

- Core Beliefs: Those fundamental principles that consciously or unconsciously influence one's ethical conduct and ethical thinking. Even when unacknowledged, core beliefs shape one's responses. Core beliefs can reflect one's environment, religion, culture or training. A person may or may not choose to act on their core beliefs.
- Ethical Perspectives/concepts: The different theoretical means through which ethical issues are analyzed, such as ethical theories (e.g., utilitarian, natural law, virtue) or ethical concepts (e.g., rights, justice, duty).
- Complex, multi-layered (gray) context: The sub-parts or situational conditions of a scenario that bring two or more ethical dilemmas (issues) into the mix/problem/context/for student's identification.
- Cross-relationships among the issues: Obvious or subtle connections between/among the sub-parts or situational conditions of the issues present in a scenario (e.g., relationship of production of corn as part of climate change issue).

Ethical Reasoning VALUE Rubric

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Association of American Colleges and Universities

Definition

Ethical Reasoning is reasoning about right and wrong human conduct. It requires students to be able to assess their own ethical values and the social context of problems, recognize ethical issues in a variety of settings, think about how different ethical perspectives might be applied to ethical dilemmas, and consider the ramifications of alternative actions. Students' ethical self-identity evolves as they practice ethical decision-making skills and learn how to describe and analyze positions on ethical issues.

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone 4	**Milestones** 3	2	**Benchmark** 1
Ethical Self-Awareness	Student discusses in detail/analyzes both core beliefs and the origins of the core beliefs and discussion has greater depth and clarity.	Student discusses in detail/analyzes both core beliefs and the origins of the core beliefs.	Student states both core beliefs and the origins of the core beliefs.	Student states either their core beliefs or articulates the origins of the core beliefs but not both.
Understanding Different Ethical Perspectives/Concepts	Student names the theory or theories, can present the gist of said theory or theories, and accurately explains the details of the theory or theories used.	Student can name the major theory or theories she/he uses, can present the gist of said theory or theories, and attempts to explain the details of the theory or theories used, but has some inaccuracies.	Student can name the major theory she/he uses, and is only able to present the gist of the named theory.	Student only names the major theory she/he uses.
Ethical Issue Recognition	Student can recognize ethical issues when presented in a complex, multilayered (gray) context AND can recognize cross-relationships among the issues.	Student can recognize ethical issues when issues are presented in a complex, multilayered (gray) context OR can grasp cross-relationships among the issues.	Student can recognize basic and obvious ethical issues and grasp (incompletely) the complexities or interrelationships among the issues.	Student can recognize basic and obvious ethical issues but fails to grasp complexity or interrelationships.
Application of Ethical Perspectives/Concepts	Student can independently apply ethical perspectives/concepts to an ethical question, accurately, and is able to consider full implications of the application.	Student can independently apply ethical perspectives/concepts to an ethical question, accurately, but does not consider the specific implications of the application.	Student can apply ethical perspectives/concepts to an ethical question, independently (to a new example) and the application is inaccurate.	Student can apply ethical perspectives/concepts to an ethical question with support (using examples, in a class, in a group, or a fixed-choice setting) but is unable to apply ethical perspectives/concepts independently (to a new example.).
Evaluation of Different Ethical Perspectives/Concepts	Student states a position and can state the objections to, assumptions and implications of and can reasonably defend against the objections to, assumptions and implications of different ethical perspectives/concepts, and the	Student states a position and can state the objections to, assumptions and implications of, and respond to the objections to, assumptions and implications of different ethical perspectives/concepts, but the student's response is inadequate.	Student states a position and can state the objections to, assumptions and implications of different ethical perspectives/concepts but does not respond to them (and ultimately objections, assumptions, and implications are compartmentalized by	Student states a position but cannot state the objections to and assumptions and limitations of the different perspectives/concepts.

	student's defense is adequate and effective.		student and do not affect student's position.)	

Creative Thinking VALUE Rubric

for more information, please contact value@aacu.org

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Definition

Creative thinking is both the capacity to combine or synthesize existing ideas, images, or expertise in original ways and the experience of thinking, reacting, and working in an imaginative way characterized by a high degree of innovation, divergent thinking, and risk taking.

Framing Language

Creative thinking, as it is fostered within higher education, must be distinguished from less focused types of creativity such as, for example, the creativity exhibited by a small child's drawing, which stems not from an understanding of connections, but from an ignorance of boundaries. Creative thinking in higher education can only be expressed productively within a particular domain. The student must have a strong foundation in the strategies and skills of the domain in order to make connections and synthesize. While demonstrating solid knowledge of the domain's parameters, the creative thinker, at the highest levels of performance, pushes beyond those boundaries in new, unique, or atypical recombinations, uncovering or critically perceiving new syntheses and using or recognizing creative risk-taking to achieve a solution.

The Creative Thinking VALUE Rubric is intended to help faculty assess creative thinking in a broad range of transdisciplinary or interdisciplinary work samples or collections of work. The rubric is made up of a set of attributes that are common to creative thinking across disciplines. Examples of work samples or collections of work that could be assessed for creative thinking may include research papers, lab reports, musical compositions, a mathematical equation that solves a problem, a prototype design, a reflective piece about the final product of an assignment, or other academic works. The work samples or collections of work may be completed by an individual student or a group of students.

Glossary

The definitions that follow were developed to clarify terms and concepts used in this rubric only.

- Exemplar: A model or pattern to be copied or imitated (quoted from www.dictionary.reference.com/browse/exemplar).
- Domain: Field of study or activity and a sphere of knowledge and influence.

Creative Thinking VALUE Rubric

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Association of American Colleges and Universities

Definition

Creative thinking is both the capacity to combine or synthesize existing ideas, images, or expertise in original ways and the experience of thinking, reacting, and working in an imaginative way characterized by a high degree of innovation, divergent thinking, and risk taking.

Evaluators are encouraged to assign a zero to any work sample or collection of work that does not meet benchmark (cell one) level performance.

	Capstone	**Milestones**		**Benchmark**
	4	3	2	1
Acquiring Competencies *This step refers to acquiring strategies and skills within a particular domain.*	Reflect: Evaluates creative process and product using domain-appropriate criteria.	Create: Creates an entirely new object, solution or idea that is appropriate to the domain.	Adapt: Successfully adapts an appropriate exemplar to his/her own specifications.	Model: Successfully reproduces an appropriate exemplar.
Taking Risks *May include personal risk (fear of embarrassment or rejection) or risk of failure in successfully completing assignment, i.e. going beyond original parameters of assignment, introducing new materials and forms, tackling controversial topics, advocating unpopular ideas or solutions.*	Actively seeks out and follows through on untested and potentially risky directions or approaches to the assignment in the final product.	Incorporates new directions or approaches to the assignment in the final product.	Considers new directions or approaches without going beyond the guidelines of the assignment.	Stays strictly within the guidelines of the assignment.
Solving Problems	Not only develops a logical, consistent plan to solve problem, but recognizes consequences of solution and can articulate reason for choosing solution.	Having selected from among alternatives, develops a logical, consistent plan to solve the problem.	Considers and rejects less acceptable approaches to solving problem.	Only a single approach is considered and is used to solve the problem.
Embracing Contradictions	Integrates alternate, divergent , or contradictory perspectives or ideas fully.	Incorporates alternate, divergent , or contradictory perspectives or ideas in a exploratory way.	Includes (recognizes the value of) alternate, divergent , or contradictory perspectives or ideas in a small way.	Acknowledges (mentions in passing) alternate, divergent, or contradictory perspectives or ideas.
Innovative Thinking *Novelty or uniqueness (of idea, claim, question, form, etc.)*	Extends a novel or unique idea, question, format, or product to create new knowledge or knowledge that crosses boundaries.	Creates a novel or unique idea, question, format, or product.	Experiments with creating a novel or unique idea, question, format, or product.	Reformulates a collection of available ideas.

Connecting, Synthesizing, Transforming	Transforms ideas or solutions into entirely new forms.	Synthesizes ideas or solutions into a coherent whole.	Connects ideas or solutions in novel ways.	Recognizes existing connections among ideas or solutions.

PENNSTATE

Problem Solving Rubric

This scale evaluates the process employed in response to a problem-solving task. It takes into consideration the level of student knowledge and understanding with respect to the given problem solving task; the selection and implementation of appropriate procedures and/or strategies; and the accuracy of the solution obtained.

4 - Response is characterized by all of the following:
- The student selects and implements relevant concepts and procedures/strategies needed to solve this problem.
- The student considers all constraints of the problem situation.
- The solution and all relevant work is correct; or, there is a mistake due to some minor computational or copying error.

3 - The student selects appropriate procedures/strategies to solve this problem; however, the response/solution is not entirely correct because one of the following is apparent:
- There is evidence the student has a misconception or has failed to consider a relevant concept needed to solve the problem correctly.
- The student fails to consider a constraint of the problem situation.
- The student has considered an irrelevant variable or failed to consider a relevant variable.
- The response/solution is generally correct; however, from the information provided it is not completely clear how the student arrived at this solution.

2 - The student selects appropriate procedures/strategies to solve this problem; however, the response/solution is not correct because one or more of the following are:
- There is evidence that the student has several misconceptions or has failed to consider several relevant concepts needed to solve the problem correctly.
- The student fails to consider several constraints of the problem situation.
- The student has also considered several irrelevant variables or failed to consider several relevant variables.
- The student did not carry the procedures/strategies far enough to reach a solution.
- The response/solution is generally correct; however, there is no information showing how the student arrived at this response/solution.

1 - An incomplete and/or incorrect response/solution is provided evidencing an attempt to solve the problem. In addition, one or more of the following are apparent:
- The student did consider a constraint or variable of the problem situation.
- The student understands some concepts relevant to the problem task.
- The student selected a totally inappropriate procedure/strategy.

0 - Response is characterized by the following:
- It is blank.
- The student response only repeats information in the problem task.
- An incorrect solution/response is given and no other information is shown.
- The solution/response and supportive information is totally irrelevant to the problem task.

Reference:

National Center for Research on Evaluation, Standards, and Student Testing (CRESST)

INTERNSHIP JOURNAL GRADING RUBRIC

	Poor	Fair	Good	Excellent	POINTS
Content (50 pts)	Content is incomplete. Major points are not clear or not thorough. Required content is unanswered, or was inadequately addressed. Journal is inadequate in depth of thought. (0-25 pts)	Content is not comprehensive or persuasive. Major points are addressed but not well supported. Responses are inadequate or content is inconsistent with regard to purpose or clarity of thought. (26-38 pts)	Content is adequate. Major points are stated. Discussion is adequate and addresses the requirements. Content and purpose of the journal are clearly articulated. (38-43 pts)	Content is comprehensive and persuasive. Major points are stated clearly and are well supported. The journal is excellent, addressing the assignment and incorporating the required content. (44-50 pts)	
Organization & Structure (40 pts)	Organization and structure detract from the message of the journal. Points are disjointed and lack transition. (0-20 pts)	Structure of the journal is not easy to follow. Transitions need improvement. Insights do not flow from the rest of the journal. (21-30 pts)	Structure is mostly clear and easy to follow. Transitions are present. Conclusions are logical. (31-35 pts)	Structure of the journal is very clear and easy to follow. Transitions are logical and maintain the flow of thought throughout the journal. The conclusions are logical and flow from the rest of the writing. (36-40 pts)	
Grammar, punctuation & spelling (10 pts)	Journal contains numerous grammatical, punctuation, and spelling errors. (0-4 pts)	Journal contains a few grammatical, punctuation, and spelling errors. (5-6 pts)	Rules of grammar, usage and punctuation are followed with only minor errors that do not detract from the readability of the work. Spelling is correct. (7-8 pts)	Rules of grammar, usage, and punctuation are followed. Spelling is correct. Language is clear and precise. Sentences display strong, varied structure. (9-10 pts)	
				TOTAL	

THE PENNSYLVANIA STATE UNIVERSITY

Fall 2018

COURSE NUMBER: ENGR 120N

COURSE TITLE: Design Thinking and 3D Printing in Engineering and Healthcare

CREDIT HOURS: 3 SH

CATALOG DESCRIPTION:
Design Thinking and 3D Printing in Engineering and Healthcare (ENGR 120N) is an introductory course allowing students to explore concepts in digital art, science, health, and technology through team-based and individual studio work. Students will be encouraged to secure a foundation of multiple disciplines through collaborative exploration of art, engineering and biomedical topics. Promotion of Design Thinking concepts (empathize, define, create, prototype, and test) will be encouraged to increase understanding of the complexities 3D design, the human body, and to appreciate empathic understanding. Students will be introduced to basic human health and anatomy; Design Thinking; empathic understanding; iteration; financial, distribution, and ethical considerations.

GENERAL EDUCATION LEARNING OBJECTIVES ADDRESSED IN COURSE:

1. *KEY LITERACIES* – the ability to identify, interpret, create, communicate, and compute using materials in a variety of media and contexts. Literacy acquired in multiple areas, such as textual, quantitative, information/technology, health, intercultural, historical, aesthetic, linguistic (world languages), and scientific, enables individuals to achieve their goals, to develop their knowledge and potential, to lead healthy and productive lives, and to participate fully in their community and wider society.
2. *INTEGRATIVE THINKING* – the ability to synthesize knowledge across multiple domains, modes of inquiry, historical periods, and perspectives, as well as the ability to identify linkages between existing knowledge and new information. Individuals who engage in integrative thinking are able to transfer knowledge within and beyond their current contexts.
3. *CREATIVE THINKING* – the capacity to synthesize existing ideas, images, or expertise in original ways and the experience of performing, making, thinking, or acting in an imaginative way that may be characterized by innovation, divergent thinking, and intellectual risk taking.
4. *SOCIAL RESPONSIBILITY AND ETHINCAL REASONING* – the ability to assess one's own values within the social context of problems, recognize ethical issues in a variety of settings, describe how different perspectives might be applied to ethical dilemmas, and consider the ramifications of alternative actions. Individuals should acquire the self—knowledge and leadership skills needed to play a role in creating and maintaining healthy, civil, safe, and thriving communities.

COURSE OBJECTIVES:

By the end of the course, students should be able to:

1. Demonstrate competence in the creation of original designs in the areas of engineering and healthcare.(GA).
2. Demonstrate a basic knowledge and comprehension of artistic components of Design Theory (GA).
3. Demonstrate competence in the analysis, critical thinking, and interpretive reasoning through the exploration of Design Thinking (GA).
4. Explain evidence-based practice methodology of 3D printing in healthcare. (GN).
5. Demonstrate informed understandings of biomedical claims and how they can apply to 3D design using Design Thinking (GN).
6. Identify societal, ethical, financial, and philosophical implications of discoveries in Engineering and healthcare and how they have the potential to address contemporary problems (GN).

TOPICAL OUTLINE:

I. Introduction to course
II. Design Thinking and Creative Process
III. Engineering/3D printing Basics
IV. Healthcare Applications
V. New Technologies
VI. Interdisciplinary Implications (Legal, Financial, Ethical, etc)

TEACHING METHODOLO GIES MAY INCLUDE :

Lecture, Discussion, Audiovisuals, Self-Assessment, Reflective Analysis, Critical Thinking/Problem Solving, Online modules, Studio

EVALUATION METHODS:

Evaluation methods may include quizzes, design and fabrication of projects, in-class debates, presentations, studio participation, online discussion boards, case studies, posters and final art show participation.

MAKE-UP EXAMS:

There will not be make-up opportunities for in-class quizzes or debates.

REQUIRED AND RECOMMENDED TEXTS:

Lipson, H. and Kurman, M. (2013). Fabricated: The new world of 3D printing. Indianapolis, IN: Wiley.

Luchs, M.G., Swan, K.S., and Griffin, A. (Eds.). (2016). Design thinking. Hoboken, NJ: Wiley.

GRADE REQUIREMENT:

Students must achieve a letter grade of C or better in order to pass the course.

ACADEMIC INTEGRITY:
Academic integrity is the pursuit of scholarly activity free from fraud and deceptions and is an educational objective of this institution. Academic dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating of information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examination, making copies in any manner of exams or papers, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. At the beginning of each course, it is the responsibility of the instructor to provide a statement clarifying the application of academic integrity criteria to that course. A student charged with academic dishonesty will be given oral or written notice of the charge by the instructor. If students believe they have been falsely accused, they should seek redress through normal discussion with the instructor, department head, dean, or campus executive officer. If the instructor believes that the infraction is sufficiently serious to warrant referral of the case to the Office of Student Conduct, or if the instructor will award a final grade of "F" in the course because of the infraction, the student and instructor will be afforded formal due process (review Academic Integrity information, policy and procedure at http://www.nursing.psu.edu/undergraduate/academic-integrity).

COUNSELING AND PSYCHOLOGICAL SERVICES :
Penn State's Counseling and Psychological Services (CAPS) offers mental health services to students. Services are designed to enhance the students' ability to fully benefit from the University environment and academic experience. Services are free and confidential. In case of emergency, call 911. To schedule an appointment with CAPS call or visit:

- **Fayette** : 724-430-4122
  http://www.fe.psu.edu/StudentServices/counseling.htm

DISABILITY STATEMENT :
Every Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. Student Disability Resources (SDR) Web site provides contact information for every Penn State campus: http://equity.psu.edu/sdr/disability-coordinator. For further information, please visit Student Disability Resources Web site: http://equity.psu.edu/sdr.

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: http://equity.psu.edu/sdr/guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

DIVERSITY STATEMENT:
By respecting differences in culture, age, gender, gender expression, race, ethnicity, national origin, differing abilities, sexual orientation, and religious affiliation, we enrich the learning

environment; improve practice and professionalism; and enhance personal creativity and professional growth.

ATTENDANCE, STUDENT RESPONSIBILITIES AND CONDUCT:

1. Attendance and participation in all scheduled classes/studio time is expected. Excessive absence can seriously affect a student's success in passing this course.
2. If an evaluative event (exam, quiz, presentation or other form of assessment for grading) will be missed due to an unavoidable absence, the student must contact the instructor **prior** to the scheduled evaluative event.
    a. If the student does not contact the Course coordinator/instructor prior to the evaluative event, it will be considered an unexcused absence and an opportunity to take a make-up exam will not be offered.
    b. Students will be held responsible for using only legitimate, unavoidable reasons for requesting a make-up in the event of a missed class or evaluative event. Requests for missing class or an evaluative event due to reasons that are based on false claims may be considered violations of the policy on Academic Integrity.
3. Students are responsible for keeping track of changes in the course syllabus made by the instructor throughout the semester.
4. Students are responsible for monitoring their grades.
5. If extra credit assignments are offered, they must be offered to all students and should not be used to boost the grade of an individual student.
6. Behaviors that disrupt other students' learning are not acceptable (e.g., arriving consistently late for class, cell phone use, reading non-course related materials, or social conversation during class), and will be addressed by the instructor.
7. For severe and chronic problems with student disruptive behavior, the Senate Committee on Student Life Policy on Managing Classroom Disruption will be followed. (http://studentaffairs.psu.edu/conduct/Disruptions.shtml)

FACULTY:

Nathaniel Bohna, PhD
Office: 301a Eberly Building
Hours: By appointment
Phone: 724-430-4109
Email: nab141@psu.edu

Valerie Vanderhoff, DNP, RN
Office: 216 Bio Medical Building
Hours: By appointment
Phone: Office 724-430-4188. Cell 724-787-0658 between the hours of 9am-9pm Monday thru Friday, Sat by availability. *Not available on Sundays.*
Email: vuv3@psu.edu

ADDITIONAL PSU CAMPSU RESOURCES/POLICIES

The Learning Center
(TLC) supports the academic success of all Penn State Fayette students and aims to help students meet their academic goals. TLC provides free one-to-one and group tutoring sessions in writing, math, science, general study and time management skills, and most other classes. We are committed to working with students from all disciplines, majors, and academic backgrounds at any point in their study. We not only provide help for students who feel they are struggling, but we also seek to help students who wish to remain strong in their courses. Use the online scheduling system at https://eberly.mywconline.com to schedule a session, or contact TLC for assistance.

Location: Student Success Center – Upper Level of Williams
Phone: 724-430-4119
Email: tlcfayette@psu.edu

Fayette OWL ***NEW PROCESS ***
If you need writing help for any class, consider using the Fayette Online Writing Lab (OWL). Through the OWL, you can receive tutoring online at a time that's best for you. Writing tutors will help at any stage of your writing process (brainstorming, planning, drafting, revision). To learn more about the OWL and to submit a request for assistance, go to http://sites.psu.edu/fayetteowl

COPYRIGHTS

All course materials students receive or to which students have online access are protected by copyright laws. Students may use course materials and make copies for their own use as needed, but unauthorized distribution and/or uploading of materials without the instructor's express permission is strictly prohibited. University Policy AD 40, Recording of Classroom Activities and Note Taking Services, addresses this issue. Students who engage in the unauthorized distribution of copyrighted materials may be held in violation of the University's Code of Conduct and/or liable under Federal and State laws.

FE TOBACCO POLICY

Penn State Fayette restricts the use of e-cigarettes and all tobacco products (including but not limited to cigarettes and smokeless tobacco) to the designated areas throughout the campus. Use of e-cigarettes or tobacco products is prohibited inside any Penn State Fayette facility.

ADDITIONAL REQUIRMENTS:

******PollEverywhere.com*

Students will be required to download this free app to your phone/laptop and to bring either to class. We will walk through how to complete this process during the first class meeting and have a "practicerun" so that students may fully engage in classroom activities. It is expected that students will log into the Polleverywhere site at the beginning of each class upon arrival and be prepared to engage in discussion using this online technology.

**Microsoft Word access*

ALL assignments are to be in Word. *PDF files cannot be accepted.* PDF files are very difficult to correct in-text. Late submissions will not be excused if submitted in PDF and then there is a delay to convert to Word. Any lost points will be applied to submissions that are posted in PDF format.

**Canvas*

Students need to become familiar with Canvas, PSU's Learning Management System (LMS). Canvas is the platform used for email communication, submission of assignments, grade posting and general announcements. Students need to enroll in the class and have a student ID to access this LMS.

**Microsoft Publisher*

Students need to become familiar with Microsoft Publisher in order to prepare a poster for the final presentation during the Learning Fair. Students will receive support in this process from course instructors, campus IT personnel and online learning modules.

PROFESSIONAL CHANNELS OF COMMUNICATION POLICY:

All course communication should be directed to the primary instructor of the lecture content. Please see contact information listed above to get into touch with the appropriate instructor. If contact cannot be made with the primary instructor of content, an attempt may be made to contact the secondary instructor with the understanding that the secondary instructor will facilitate communication to the primary instructor. The secondary instructor alone will not address conflict issues.

SYLLABUS SUBJECT TO CHANGE STATEMENT:

We anticipate that we will follow the schedule we have outlined here, but we may make adjustments based on what actually happens in class. Be sure to check with a classmate after an absence to see if assignments have changed. Remaining in the course after reading this syllabus will signal that you accept the possibility of changes and responsibility for being aware of them.

GRADE REQUIREMENTS:

Attendance/participation/studio time (15 wks-4 pts each)	60
3D projects design & printing (4 projects-10 pts each)	40
Midterm Group Project	25
Design Portfolio (art & journal. 7 entries-5 pts each)	35
Case Studies (3-15 points each)	45
Online Discussion Board (15 entries-4 pts each)	60
Final-Art show submission	35
	300 PTS TOTAL

Assignments submitted after the due date without prior approval will have one **point** deducted for each late day (**including Saturday, Sunday and Holidays**).

Attendance/participation/studio time (15 wks-4 pts each).
Students will be expected to attend weekly class and to spend a minimum of 1 hr/week in the studio working on design projects. The studio is located on the 3rd floor of Eberly Building. Computers are also available in the adjacent classroom for design work if class is not in session.

3D projects design & printing (4 projects-10 pts each)
Students will be expected to complete a minimum of four 3D printed projects throughout the course. Designs may be from online sources, scanned, or original works. Guidelines/focus for each project will be outlined on Canvas. Rubrics will be available to help guide your project development.

Midterm Group Project
Students will work in groups to design game or puzzle pieces. Students will be responsible for designing an individual piece. The group will be responsible on choosing a theme that will tie all individual pieces together. Students will evaluate each group member as part of s 360° evaluation process.

Design Portfolio (art & journal. 7 entries-5 pts each)
Students will keep a journal and collection of designs/artwork. Journal entries will be due every 2 weeks. Topics may be themed per instructor(s) and/or reflect an individual's journey of discovery, deliberation, and artistic design inspiration.

Case Studies (3-15 points each)
Students will be required to complete 3 case studies and post reflections on Canvas. Case studies will incorporate financial, ethical, and legal issues surrounding the topics of the course.

Online Discussion Board (15 entries-4 pts each)
Students will be required to post weekly on topics determined by instructors that may include where to find online designs, application of 3D design in art, engineering, and biomedical arenas, new technologies, government involvement, financial influences, legal implications, ethical dilemmas, and proprietary rights.

Final-Art show submission
Students will chose a design developed over the semester for display at the Learning Fair. Students will be required to create a Microsoft Publisher poster that describes their journey throughout the semester in Design Thinking process.

STUDENT SUCCESS CENTER
Location: Student Success Center – Upper Level of Williams
Phone: (724) 4304119
Email: tlcfayette@psu.edu

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Students may access a scheduled remote consult with a Learning Center tutor by going to **meeting.psu.edu/fowl** at the agreed upon time. The tutor will give you access to the live chat for feedback on your previously submitted paper/assignment.

Aesthetic and design considerations, modifications, and applications of materials, processes and
3D production processes with digital file creations and online resources
Class self-selection of midterm groups.

THE PENNSYLVANIA STATE UNIVERSITY
ENGR 120N
Fall 2018

	Midterm Workshop