Societal-Impact and Ethics Course Content Description and ABET #4 Aligned Outcomes

UCLA Engineering Faculty Submissions

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SOCIETAL-IMPACT & ETHICS COURSE CONTENT DESCRIPTION & OUTCOMES TEMPLATE

Email completed form or send questions to Pilar O'Cadiz: mpocadiz@tanms.ucla.edu

Course Number:

Course Name:

Submitting Faculty Name:

Faculty Email:

COURSE CONTENT DESCRIPTION

- Describe the specific societal impact topics or ethics issues that are addressed in the course.

  [Insert description of new societal/ethics content here]

- Specify the time dedicated to cover this content through lecture and other in-class learning activities (e.g. videos, class discussions). We encourage that the equivalent of one course lecture period (100 min.) be dedicated, either in one class period or distributed throughout the quarter (e.g., six-minute vignette at beginning or end of each lecture; or five 20-minute presentations/discussion sessions distributed over the 10-week quarter).

  [Insert brief description of time dedicated to content here]

OUTCOMES

- Provide at least one or two course student learning outcomes aligned with the ABET Student Outcome Criteria #4: **The ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.**
- Current course outcomes can be viewed at https://my.engineering.ucla.edu
  Under the Accreditation tab are the survey questions that students answer when they complete the course evaluation at the end of the quarter. Students are asked to rate the extent to which they acquired specific knowledge or skills related to each stated outcome for that course.

Outcome 1:

Outcome 2 (optional):

Add additional outcomes if appropriate.

CEE 120
Principles of Soil Mechanics

Submitting Faculty: Scott Brandenberg
Faculty Email: sjbrandenberg@ucla.edu

COURSE CONTENT DESCRIPTION

- **Description of specific societal impact topics or ethics issues that are addressed in the course:**

This course is required for all Civil and Environmental Engineering undergraduate students and presents the basics of soil mechanics and geotechnical engineering. This is the first course in geotechnical engineering, and it is therefore very important to establish why the fundamental concepts presented in the course are important with respect to an Engineers obligation to society. In the very first lecture of the quarter, I spent 60 minutes discussing geotechnical failures, the impacts those failures had on society, and the reasons for the failures. I discuss the Teton Dam, which failed in 1976 killing 11 people and 13,000 cattle in Idaho. The dam was constructed by the US Bureau of Reclamation near the end of the rush to construct dams for flood control and irrigation purposes. The abutments of the dam (i.e., the rock formations on either side of the valley carved by the Snake River) were very porous and ill-suited to dam construction. The engineers thought they could successfully grout the fissures in the rock, thereby making the abutments water-tight, but they were wrong and overly confident. As with many engineering failures, dissenting voices were ignored during dam construction. I then move on to a discussion of the near-failure of the lower San Fernando Dam during the 1971 San Fernando Earthquake. The embankment dam slope failed due to soil liquefaction. Had the dam failed, large portions of the San Fernando Valley would have flooded, likely killing tens of thousands of people. The reason why the dam failed is that it was constructed by a process called hydraulic fill, in which the soil is sluiced in as a slurry and allowed to settle under its own weight. Although cost-effective, this construction method makes dams susceptible to liquefaction. This case history hits close to home for many students because it is so close to UCLA. I then ask students for their opinion about what can be done to solve these problems and discuss the formation of the California Division of Safety of Dams and subsequent retrofit for all hydraulic fill dams in the State. In a separate lecture, I discuss professional licensure, including the requirements to obtain a Professional Engineering license. The rules have recently changed, and students can now take the 8-hour principles and practice portion of the exam soon after graduation. I also describe the Professional Engineers act and describe professional licensure in other fields including geology. I also provide a brief overview of geology and discuss typical interactions between geotechnical engineers and geologists in engineering projects.

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

The first lecture devotes an hour to presenting and discussing engineering failures. The lecture on professional licensure occupies about 20 minutes, and the lecture on geology and interactions between engineers and geologists occupies 40 minutes.

OUTCOMES

- **Aligned with ABET Student Outcome Criteria #4**

Outcome 1: Students will understand the impacts of engineering failures on society by learning about past case histories of dam failures, consequences of the failures, their causes, and the responsibility of Engineers to prevent such failures.

Outcome 2: Students will understand professional licensure for Civil Engineers, including the process for obtaining a Professional Engineers license and the legal responsibilities it entails via the Professional Engineers Act.

Course Number: **CH ENGR 104B**

Course Name: **Chemical and Biomolecular Engineering Laboratory II**

Submitting Faculty Name: Dante Simonetti

Faculty Email: dasimonetti@ucla.edu

COURSE DESCRIPTION

- **Description of specific societal impact topics or ethics issues that are addressed in the course:**

  The specific societal impact topics addressed in this course deal with the technical benefits delivered by the technologies associated with laboratory experiments. This topic relates to the questions of what problem has the technology solved, how has human life improved from this solution, and what scope of the human population benefited (i.e., how many individuals). The specific ethics issues addressed in this course deal with financial gain and/or disproportionate benefits delivered by the technology. Specific questions addressed for this issue are: Who stands to gain from the solution? What are the alternative technologies and why aren't we pursuing those? Are there any individuals or groups that are exploited by using this technology? What are the environmental impacts of this technology?

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

  Students in this course perform 4 experimental investigations during the course (920 minutes total for each investigation). Each investigation requires a written report and/or oral presentation (expected time of 150 minutes of work). One fifth of the report or presentation is devoted to discussing the societal impact topics/issues related to the investigation. Thus, it is expected that students will devote 214 minutes per investigation for research and writing activities related to the societal impact components of the course.

OUTCOMES

- **Aligned with ABET Student Outcome Criteria #4**

  Outcome 1: Demonstrates an ability to infer consequences of engineering solutions to global, economic, environmental, and societal problems.

  Outcome 2: Demonstrates knowledge of current technological issues and their relation to general society.

CH ENGR 118/218

Environmental Multimedia Assessment

Submitting Faculty Name: Yoram Cohen

Email: yoram@ucla.edu

COURSE DESCRIPTION

- The course deals with real world environmental assessment associated with manufacturing and use of chemicals (including nanomaterials), releases to the environment, environmental and health risks and proposed risk mitigation strategies. The course covers aspects of the beneficial use of chemicals and the need for responsible manufacture and use of chemicals that considers the need to protect human health and the environment. The course introduces the students to concepts of toxicity, environmental justice and economic impacts associated with manufactured chemicals and strives to develop an understanding and an engineering road map for sustainable and responsible manufacturing.

  This course is an essential component in the education of engineering and science students who need to understand the connection between engineering, the environment and sustainability. Engineering students must understand the impact of industrial manufacturing (in all engineering disciplines) on the environment in order to understand not only the benefit of industrial processes and product use, but also to appreciate their potential risks and the approaches that should be taken to mitigate societal risks and develop sustainable industries.

- The course focuses on environmental impact assessment considering the release of pollutants to the environment (associated with industrial activities) and the transport of pollutant through and among the various environmental compartments (i.e., air, soil, groundwater, water bodies, sediment, vegetation, biota), as well as transformation of chemicals in the natural environment. The students are introduced to real world examples of environmental impact assessment. Material is drawn from actual research work done by UCLA Faculty and students in connection with various impact assessment studies. Examples include the Santa Susana Field Laboratory site, Valdez Oil Loading Terminal, DDT in Torrance, Stringfellow Acid Pits, VOCs and PAHs and Nitro-PAHs in Los Angeles and more. A critical component of the course is a term team project in which the students are assigned a particular geographical region in the U.S. and are guided through the process of conducting an environmental impact assessment for a specific chemical(s) and then propose suitable risk mitigation strategies. The project follows the accepted first-level impact assessment as conducted by professionals in the field.

  In addition to weekly homework assignments, the students are engaged in a team term-project with weekly reporting and illustrative problems that are relevant to the project. Student teams provide weekly presentations (briefings) on their project progress (including identification of problem areas) in a discussion session with all other project teams. The course and project follow the main steps of identifying and quantifying environmental and health risks associated with anthropogenic pollution sources and proposing mitigation strategies.

- Course topics include: (1) Introduction on environmental pollution and its impact on our environment, environmental regulations, exposure and risk; (2) Pollution sources, (3) Pollution control, (4) Dispersion of pollutant in the environment, (5) Transport of Chemicals Across Environmental Phase Boundaries; (6) Multimedia Modeling of Pollutant Partitioning in the Environment; (7) Exposure analysis; (8) Risk analysis; (9) Group projects: student teams conduct detailed environmental impact analysis for a given region and pollutants of concern. The teams assess the extent of environmental and societal risks associated with the release and potential exposure to specific contaminants in a selected region and then propose risk mitigation strategies.

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

  Course time devoted to addressing Societal impacts and ethics:
  - Lectures: 50% of the lectures time
  - Discussion sessions: 60-80% of the discussion session time
  - Term project: 50% of the student project effort is dedicated to societal impact/ethics
  - Homework Problems: 25% of the HW problems are related to societal impact
    (Note: portions of the course that deal with mechanistic details of contaminant transport are excluded from the above estimates, although are related to developing an understanding of the societal/environmental impacts of contaminants).

OUTCOMES

- **Aligned with ABET Student Outcome Criteria #4**
  The course specifically addresses the impact of anthropogenic pollution sources (e.g., industrial processes, product use and disposal, vehicular emissions) on the environment and human health. Student are confronted with the reality that it is the responsibility of science and engineering professionals to understand the impact of technology and to arrive at solutions that will lead to sustainable/green engineering and minimize/avoid adverse societal impacts. In this regard, students are confronted in this course with the reality that technological advances should not impose constraints on our society but provide for positive impact on society and the environment and promote environmental justice.

  Outcome 1: Environmental pollution and its impact on our environment, Major environmental regulations, Exposure and risk.

  Outcome 2 (optional)**:** Pollution Control: Source reduction, Treatment technologies, Disposal of chemical wastes, Remediation - The penalty for past deficient environmental protection.

  Outcome 3: Multimedia Risk Analysis: Health risks: Chronic versus acute health risks, Toxicology and risk assessment: laboratory versus epidemiological studies, Ecological risks (i.e., non-human health risks), Societal risks - discussion, Uncertainties in Risk Analysis.

  Outcome 4: Group project–A multimedia exposure and risk assessment for a given chemical in a specific geographical region and development of risk mitigation strategies.

MAE M20 / CEE M20

Introduction to Computer Programming with MATLAB

Submitting Faculty: Mohammad Khalid Jawed

Email: khalidjm@seas.ucla.edu

COURSE CONTENT DESCRIPTION

The specific societal impact topics addressed in this course deal with (1) logic and conditional statements, (2) pseudocode development and its programming implementation, and (3) numerical simulation of engineering and socioeconomic systems. Students learn how to use computer programming to systematically take a decision after accounting for the given conditions and constraints. This decision-making process can involve simple logic and conditional statements or constrained/unconstrained mathematical optimization. Students learn techniques for data visualization (e.g., plotting, image processing, and video processing) and data file processing. These tools are expected to help communicate the impact of our decisions. Students also learn algorithms to solve multivariable differentiable equations and apply them to model one or more socioeconomic and engineering systems in their assignments, e.g., predator-prey models and progress of infectious diseases.

A total of 300 minutes of lecture time is spent on the above concepts during the quarter. This includes (1) 100 minutes on logic and conditional statements, (2) 100 minutes on mathematical modeling by solving differential equations, and (3) 100 minutes on data visualization and file processing. At least two homework assignments (out of a total of 7 - 10 homework assignments) test the students on these topics. The course culminates in a final project. Part of the project requires familiarity with data visualization tools.

OUTCOMES

- **ABET Student Outcome Criteria #4:**

Outcome 1: Students will learn the basic concepts of logical operations, arithmetic operations, loops, and conditional statements, and apply them to model engineering systems

Outcome 2: Students will learn algorithms for sorting, searching, and root finding; familiarize with built-in functions for these algorithms; learn to apply these algorithms to solve multivariable differential equations.

MAE 133A

Engineering Thermodynamics

Submitting Faculty: Tim Fisher

Email: tsfisher@ucla.edu

COURSE CONTENT DESCRIPTION

- Description of specific societal impact topics or ethics issues that are addressed in the course:

The class will be assigned a design problem as a culminating assignment completed by groups of 3-4 at the end of the course. The problem involves the design of a 'microgrid' process to convert fuel from methane to hydrogen. Students will be asked to develop an exergy analysis of two designs, where the reduction of exergy destruction will be the objective (note: exergy is a metric that indicates the possible amount of useful energy that can be extracted from a process; destroyed exergy is waste that takes the form of extra pollution and unused heat.).

- Time dedicated to cover this content through lecture and other in-class learning activities:

One, 100-minute lecture in Week 10 will cover the societal considerations associated with the designs: How will produced solid carbon be handled at the local level? What are the costs of the energy produced and exergy destroyed? Students will answer such questions in short essay form at the end of the assignment. Specific questions will include:

- How does the second design option decrease exergy destruction?
- What are the technical and societal benefits, if any, of using solar heating in this design, as compared to burning methane or hydrogen for pyrolysis?
- More broadly, what are the technical and societal benefits and drawbacks of microgrids?

OUTCOMES

- **ABET Student Outcome Criteria #4**

Outcome 1: Students will understand the engineering approaches and challenges of integrating renewable and clean energy systems into communities, including the associated benefits and complications.

MAE 157A

Aerospace Design Laboratory

Submitting Faculty: Raymond Mitchell Spearrin

Email: spearrin@ucla.edu

COURSE CONTENT DESCRIPTION

- **Description of specific societal impact topics or ethics issues that are addressed in the course:**

Two societal-impact topics will be integrated in the course content and lectures with goals of student recognition. (1) Students will gain perspective on professional responsibilities to members of a product-oriented team of engineers reflecting common industry organization; (2) Students will understand engineering product development in terms of both the process and as it relates to end-use applications in the aerospace industry.

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

This content will be covered in approximately a total of 100 minutes of lecture distributed over the 10-week quarter.

OUTCOMES

- **Aligned with ABET Student Outcome Criteria #4:**

Outcome 1: Students learn division of work and shared responsibilities related to product development as part of an engineering team

Outcome 2: Students learn the engineering process from concept development, design, analysis, manufacturing, and testing in the context of aerospace applications

MAE162D/E

Mechanical Engineering Design I/II

Submitting Faculty: Robert. S. Shaefer

Email: robert.shaefer@g.ucla.edu

COURSE CONTENT DESCRIPTION

- **Description of specific societal impact topics or ethics issues that are addressed in the course:**

MAE162D/E is the Senior Mechanical Engineering Capstone Design course that spans two quarters – typically, Winter and Spring – and which is required for all Mechanical Engineering undergraduate students. The course presents the basics of engineering design methodology and engineering design principles in the context of a product development cycle. Students form teams of typically 5 to 6 members and each team is asked to design, analyze, fabricate, test, and evaluate an autonomous electro-mechanical device based on a list of product design requirements and limitations, such as functions, power, size, weight, cost, etc. Starting with design concept proposals, students are instructed and guided through a formal product design cycle, which includes a conceptual design, preliminary design, final detailed design and ending in fabricating, testing, and performance evaluation of the final project. During the first Quarter (MAE162D), students are given extensive laboratory tutorials on computer aided engineering (CAD modeling and analysis) to create a "Virtual Prototype." In the second Quarter (MAE162E) and following the completion of the virtual prototype, using an NI Robotic kit (National Instrument) students are given hands-on laboratory tutorials on mechatronic system design, which they then apply to their fabricated device. Additionally, student teams are directed to stay within a given budget (less than $500) to purchase necessary components for their device and they are encouraged to scavenge parts and components from previous year's student projects to keep costs at a minimum. Early in the project teams develop and then use a Work-breakdown Schedule to delegate project design and development activities to various team members, who have to adhere and provide results within established timelines – Project Gantt Charts of design activities and progress are presented in design reports. In order for students to underline the importance of documenting their design activities, students are required to submit a series of technical reports throughout the two quarters (five reports), culminating in a detailed technical Final Design Report, which is generally well over 100 pages long. Aside from technical design activities and tasks, the Capstone Design Course is aimed to provide students the experience of contributing to best of their ability to their team's overall objectives, while remaining respectful towards all team members.

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

The time devoted to teaching students to learn how to be an effective and respectful team member is not limited to a single lecture on engineering ethics and professionalism. Instead, we continually – throughout both Quarters – monitor and discuss team dynamics and cooperation between students by holding weekly Prof.-Team meetings. During these meetings students are encouraged to discuss openly (or in private, if necessary) their grievances or 'friction' among team members. Each Prof.-Team meeting – typically 15 teams – lasts about 20 minutes and they are held on a rotating basis during lab-hours throughout the course.

Educating Future Leaders in Mechanical And Aerospace Engineering:

Aside from fostering academic excellence, the Capstone Design Course provides a unique opportunity for students to be educated in the art of **Leadership**! The underlying method of teaching leadership is to have the Capstone Design Course students experience the importance of teamwork by "**Transforming Groups into Effective Teams.**" To give an example of how we go about transforming groups into effective teams, we start give a 50-min lecture on team-building, which starts with a quote from the U.S. Olympic Water Polo Coach, Dr. Terry Schroeder, who himself received several Gold and Silver medals prior to coaching: "…I (Dr. Schroeder) ask every team player to think of himself as the leader and the captain of the team. I don't want a team and one single leader – every team member has to act as the team leader … ."

The lecture on teamwork and leadership continues by outlining common interpersonal problems that can arise in any collaborative effort, such as Project Management, Time Management, Conflict Resolution, and Communication Skills. We review conflict resolution approaches, which are predicated by asking students to (a) establish their own team policies and expectations, (b) list effective team practices, and (c) suggest means to deal with problem team members, such as "hitchhikers and couch-potatoes on teams" who try to ride on the coattail of other members. The process of team building is a continual endeavor and spans both Quarters – we hand out team building templates in the form of instructions, team skill notes, and associated forms around the middle of the first Quarter.

Topics covered during a 50-min lecture on Ethics, Teamwork, Professionalism, and Leadership include: Ethics: Review of fundamental cannons of the Code of Ethics of the National Society of Professional Engineers (followed up by a quiz); in particular, emphasis is placed on the Engineer's Creed, which asks engineers to give the utmost of performance; participate in honest enterprises; work according to the highest standards of professional conduct; to place service before profit, personal advantage, and public welfare above all other considerations. On professionalism and leadership we give a short presentation on Dr. Ernest E. Lawrence, Nobel Laureate and his quote: "In scientific work, excellence is not about technical competence, but character."

To ensure follow-through with outlined team practices among members, we explain and implement our in-house developed confidential "peer evaluation" system, which we use to adjust the final grade of every individual team member.

OUTCOMES

- Aligned with ABET Student Outcome Criteria ABET Student Outcome Criteria #4

Outcome 1: An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

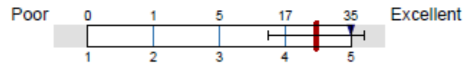
Outcome 2: Students learn to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Outcome 3: Students learn to form teams, assess required tasks, assign responsibilities and tasks, organize to meet deadlines, function as a successful team member, and develop leadership qualities.

APPENDIX: Student Evaluation – Current ABET course outcomes for ***MAE162D Winter-2021*** [1]:

4. ABET Course Outcomes (please note that these questions are required to be answered)

4.1) (a) Students will utilize the design process using math, science, and engineering concepts to configure thermal and/or electro-mechanical components, systems, or processes to fill a given need and to satisfy given design requirements and constraints.



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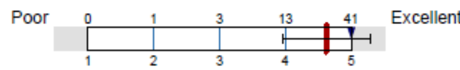
4.2) (b) Students will learn to form teams, assess required tasks, assign responsibilities and tasks, organize to meet deadlines, function as a successful team member, and develop leadership qualities.



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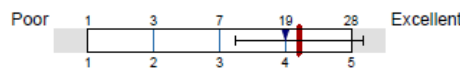
4.3) (c) Students will learn about and recognize their professional and ethical responsibilities as engineers.



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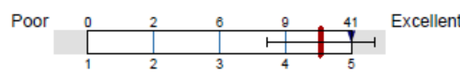
4.4) (d) Students will demonstrate clear communication, both oral and written.



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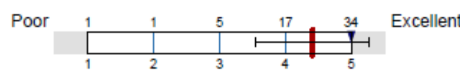
4.5) (e) Students will appreciate and recognize the need for and have the ability to acquire life-long knowledge and research through self-directed learning.



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SOURCE:

[1] R.S. SHAEFER, Evaluation of Instruction Program Report,
21W: MECH&AE 162D LEC 1: MECH DESIGN I No. of responses = 58 Enrollment = 68
Response Rate = 85.29%

MAE 163C

Control of Robotic Systems

Submitting Faculty Name: Veronica Santos

Email: vjsantos@ucla.edu

COURSE CONTENT DESCRIPTION

- Description of specific societal impact topics or ethics issues that are addressed in the course:

This elective course is cross-listed for undergraduate students (MAE C163C) and graduate students (MAE C263C). The course covers actuators, sensors, and control schemes for robotic systems. The course has direct societal impact because of the increasing use of robotics in unstructured, dynamic environments that may include interactions with humans in addition to the traditional use of robots in structured manufacturing environments. By learning how controllers are designed for robotic systems, students will gain an understanding of how engineering choices affect the performance and safety of robots. Specifically, students learn about the implications of kinematic design, actuator capabilities, task-specific selection of the controller type, and gain tuning on closed loop stability, performance metrics, and safety factors for disturbance rejection. The impact of actuator and sensor selection on the cost and complexity of robotic systems is also considered.

- Time dedicated to cover this content through lecture and other in-class learning activities:

Each lecture begins with a “Video of the Day,” with which real-world examples are incorporated into the course. The videos are themed to the lecture content and incorporate robot applications that include manufacturing, entertainment, environmental conservation, search and rescue, surgery, assistive technology, and human-robot interactions from companies and research labs all over the world. Discussion sessions include hands-on tutorials for literature reviews, robotics software used in industry, and more.

Undergraduate students complete an individual literature review project in which they research, analyze, and report on controllers designed for robotic systems. Students are taught how to find, read, critically analyze, and interpret peer-reviewed robotics publications from international conferences and journals. Many of these publications address state-of-the-art approaches to grand challenges in robotics and cite applications to societal problems. For this cross-listed course, undergraduate students also attend the final project presentations of their graduate student classmates who design controllers for robotic systems to address real-world challenges.

Societal impact-related content is covered in at least 100 minutes of instruction time distributed across lecture and discussion sessions throughout the 10-week quarter.

OUTCOMES

- **Aligned with ABET Student Outcome Criteria #4**

Outcome 1: Students learn the importance of task-relevant controller design for robotic systems that perform useful tasks for society in areas that include manufacturing and human-robot interaction.

Outcome 2: Students learn how to find, read, critically analyze, and interpret peer-reviewed robotics publications, and how to effectively present this content via written technical reports.

MAE 166A

Analysis of Aerospace Structures

Submitting Faculty: Greg Carman

Email: carman@seas.ucla.edu

COURSE CONTENT DESCRIPTION

- **Description of specific societal impact topics or ethics issues that are addressed in the course:**

This class focuses on analyzing and understanding the mechanical response of thin walled vessels such as those found in aircraft structures. The course includes constitutive relations, bending/extension of beams/plates, failure analysis, buckling calculations and aircraft design studies. The in service failure of any component in the aircraft can lead to a devasting failure with substantial loss of life. Therefore, the work conducted in this class has direct societal impact because the public continues to fear flying even though it remains one of the safest forms of transportation. This class both presents on how to ensure a safety factor is used in the design of these structures as well as the ramifications to our societal thinking if/when failures occur. The course also has several examples provided of well-known crashes and mistakes (e.g. unit mistake on a launch mission).

- **Time dedicated to cover this content through lecture and other in-class learning activities:**

During the last year, examples of recent crashes including moderate failures (e.g. window failure) have been presented throughout the course lectures. Specifically, all the work done in this class during the quarter contributes to the failure analysis which are more directly related to events during the last few weeks. Regardless, the instructor emphasizes these relationships throughout the entire course. More emphasis is given on this topic during the first class lecture to motivate the students so they understand the importance of the topic covered during this quarter long class. The emphasis on the impact failure has on our societal body is briefly covered throughout the quarter with substantially more time paid during the fatigue and failure based sections of the course.

OUTCOMES

- Aligned with ABET Student Outcome Criteria #4:

Outcome 1: Students learn the importance of stress strain calculations as they relate to failure and the impact even one aircraft crash has on our societal perspective of air travel.

Outcome 2: Students learn the importance of their attention to detail including units which have caused catastrophic failures in the past.