AAE 590 Safety and Reliability
Fall 2018

TR 10:30 to 11:45 am

Location TBD

Instructor: **Prof. Karen Marais,** kmarais@purdue.edu, ARMS 3301

Office Hours: TBD***

1 Introduction

Have you ever wondered why it's often so hard to figure out what caused an accident? Have you wondered why it's taking so long to find flight MH370? Why it took years to figure out what happened to flight AF447? Or how smart engineers could make basic unit conversion errors for weeks (Mars Climate Orbiter)?

This Fall in AAE590, Prof. Marais will be offering answers to these questions and many more. You will work individually to investigate a particular high-profile accident in detail. We will learn about the latest theories in accident progression and risk assessment, and how we can use these theories to design and operate safer systems.

The class will be interactive and feature a combination of presentations, individual work, group work, and class discussions. Grades will be based on class participation, team projects and presentations, and individual assignments and quizzes. No final exam.

The class can be taken as a design elective by seniors.

2 Contact

Please make use of office hours, during which time I am also available for phone calls. Make use of our time in class to ask lots of questions. Remember, if you're wondering about something, chances are someone else is too! Please put "590" in the subject line of all your emails to me or the TA.

3 Assignments and Evaluation

We will have three main types of assignments:

- Two individual presentations and summaries of accidents
    - Prepare a 10 minute presentation on your accident, and a one-page graphical summary. Send me drafts of both **at least two days before** your presentation. I will help you refine and improve them as needed. Accidents will be assigned in the first two weeks of class based on enrolment.

    - Your slides and summary are due on BB by noon the day before your presentation. Distance students may submit a video presentation in lieu of a live in-class presentation.
    - Some material for your case studies will be available on Blackboard
        - Also use Google and Web of Science
    - Your presentation should include
        - Story of the accident
        - Proximate causes
        - Root causes
        - Implications for risk assessment
        - References page
- Safety journal
    - Prepare a one-page max summary of each lecture. You may use the backs of the accident graphical summary sheets and summarize the material in any way you see fit (e.g., combination of text and graphics). My goal is for you to have a compact summary of the course by the end of the semester.
- One team project
    - Teams of two.
    - Investigate a safety related topic of your interest. I am open to a wide range of topics, please get in touch with me to discuss your ideas. Project proposals are due in September, see course calendar for exact dates.
    - Prepare a conference style paper and final presentation.
    - More details in class!

All assignments, presentations, etc., must be submitted on Blackboard. No email submissions will be accepted.

Your grade will be calculated as follows:

- Accident of the Week: 25%
- Term project: 45%
- Safety Journal: 15%
- Class participation: 15%

Outstanding, A. The student exhibits a high degree of critical analysis of the theoretical and practical dimensions of the topic through written and oral presentations. Mastery of complex material and ideas is immediately evident. Assignments are treated with sensitivity and subtlety of thought. The quality of the writing and background research is exemplary.

Good, B. The student shows above average analysis, critical thinking and independent thought. Written and oral assignments are addressed in reasonable depth and breadth. The student demonstrates an above average ability to present and write in an intelligible style and to condense material meaningfully and with a concern for priorities of that material.

Adequate, C. The student demonstrates adequate comprehension of the topic. Written and oral presentations are on topic and a reasonable response to material covered in the course, but go

no further. Facts are stated accurately; the quality of writing is sufficiently intelligible with enough elaboration and enough connections made between ideas to permit a reader to understand the point of the assignment.

Marginal, D. The student shows less than adequate comprehension of the material covered by the course. Written and oral presentations are a less than adequate summary of sources or are considerably off-topic. Facts are stated inaccurately or ambiguously; the writing style is difficult to follow; there is insufficient elaboration to permit reader's comprehension of relations among ideas; little judgment is shown in selecting detail for inclusion in assignments.

Unacceptable, F. The student demonstrates a failure to comprehend the topic. Written and oral presentations are disorganized and unintelligible. The student clearly does not meet the minimal requirements of the course.

4 Learning Objectives

- Describe several frameworks and theories for assessing and improving system safety
- Describe key elements of published system safety and risk assessment studies
- Understand how to develop a system safety plan
- Recognize the extent of problems in system safety and risk assessment
- Describe the role of various systems and factors in creating safety and in causing errors and adverse events
- Discuss problems and issues in measuring and reporting safety
- Demonstrate knowledge of the basics of conducting an incident or accident investigation
- Design solutions to improve safety
- Understand the ethical, legal, and regulatory implications related to safety
- Compare the different types of instruments/methods available to assess system safety
- Critique the use of commonly used system safety and risk assessment techniques in specific applications

5 2016 Course Outline, subject to minor modifications

Here is a general idea of how we'll be progressing this semester. Readings, assignments and due dates for later in the semester will be finalized as we progress.

~ August 2016 ~	
Tue	**Thu**
23 1. Introduction and logistics. In-class accident analysis. Form pairs, sign up for Accident of the Week. Term paper. Read: Bahr (2014) Ch. 1	**25** 2. System Theory and System Safety Read: https://www.atsb.gov.au/publications/investigation_reports/2008/aair/ao-2008-070.aspx AND http://research.microsoft.com/en-us/um/people/mbj/Mars_Pathfinder/Mars_Pathfinder.html AND http://research.microsoft.com/en-us/um/people/mbj/Mars_Pathfinder/Authoritative_Account.html
30 3. What is risk? Reliability vs. safety. Read: Feynman on Challenger: http://science.ksc.nasa.gov/shuttle/missions/51-l/docs/rogers-commission/Appendix-F.txt	
~ September 2016 ~	
Tue	**Thu**
	1 4. Risk Identification Read: Pidgeon, N., (2012) Complex Organizational Failures: Culture, High Reliability, and Lessons from Fukushima, The Bridge, Fall 2012 Ed., National Academy of Engineering, United States. AND FAA AC 20-128A AND Boeing Battery Fire NTSB Report: http://www.ntsb.gov/investigations/AccidentReports/Pages/AIR1401.aspx
6 5. Responding to Risk Accidents: (1) Three Mile Island and (2) Chernobyl Read: Slovic, P., (1987) Perception of Risk, Science, New Series, Vol 236, Issue 4799, 14 Apr 1987, pp 280-287. AND http://articles.latimes.com/2014/apr/14/opinion/la-oe-turley-ford-pinto-gm-cobalt-20140414 AND http://www.newyorker.com/magazine/2015/05/04/the-engineers-lament	**8** 6. Risk Perception, Cognitive Biases Accidents: (3) Bhopal and (4) Texas City Read: Slovic, P., (1987) Perception of Risk, Science, New Series, Vol. 236, Issue 4799, 14 Apr 1987, pp 280-287.
13 7. Risk Communication Accidents: (5) Battleford and (6) Walkerton Read: The naked launch: assigning blame for the Challenger explosion. AND Crash!: Nuclear fuel flasks and anti-misting kerosene on trial. Both in Harry Colllins and Trevor Pinch (2002) The Golem at Large: What you should know about technology. Available online at Purdue libraries.	**15** Guest Speaker TBD. Watch: Piper Alpha movie Read: TBD Write: A written response. Format and requirements will be posted on BB. Project Proposals Due
20 8. System Safety and Hazards Accidents: (7) Lac-Megantic Derailment and (8) Mount Polley Mine Disaster Read: Bahr (2014) Ch. 2 and 3 + TBD	**22** 9. Human Factors Accidents: (9) Piper Archer – Aeromexico DC-9 and (10) Colgan Read: TBD
27 10. Software Accidents: (11) Ariane 5, (12) Mars Polar Lander,(13) Mars Climate Orbiter Read: TBD	**29** 11. Risk Matrices and Risk Visualization Accidents: (14) Therac 25 and (15) Panama radiation therapy dose miscalculation Read: TBD
~ October 2016 ~	
Tue	**Thu**

4 12. Preliminary Hazard Analysis Accidents: (16) Valujet and (17) Swissair 111 Read: Bahr (2014) Ch. 5 + TBD	**6** 13. Energy Trace/Barrier Analysis Accidents: (18) Cali and (19) Qantas Flight 72 Read: TBD
11 Fall Break NO CLASS	**13** 14. Common Cause Analysis Accidents: (20) Upper Big Branch Mine Disaster and (21) Sago Mine Disaster Read: TBD
18 15. Functional Hazard Analysis Accidents: (22) CDG Terminal 2E collapse and (23) Hyatt Regency Walkway Collapse Read: Bahr (2014) Ch. 6 + TBD	**20** 16. FMECA Accidents: (24) United Flight 173 and (25) DC-19 Sioux City Read: Bahr (2014) Ch. 8 + TBD Project Updates Due
25 17. Fault Tree Analysis Accidents: (26) Tenerife and (27) Air France447 Read: Bahr (2014) Ch. 7 + TBD	**27** 18. Fault Tree Analysis Cont. Accidents: (28) USAir Flight 427 and (29) Black Hawk Friendly Fire Shootdown Read: TBD
~ November 2016 ~	
Tue	**Thu**
1 19. Combinatorial Failure Probability Analysis Accidents: (30) Boeing C-17A Globemaster and (31) Royal Navy Westland Sea King Read: TBD	**3** 20. Event Tree Analysis Accidents: (32) NTSB Identification: ERA13FA088 and (33) NTSB Identification: ERA12FA196 Read: TBD
8 21. Other Techniques Accident: (34) Space Shuttle Columbia + (35) Space Shuttle Challenger Read: Bahr (2014) Ch. 9 + TBD	**10** 22. Safety Cases Accident: Uncontained Engine Failures (36) SWA August 2016 and (37) Qantas Flight 32 Read: TBD
15 23. Safety Cases Cont. Accident: (38) Gimli Glider and (39) Captain Sully Read: TBD	**17** 24. Catch up Day Read: TBD
22 Project Review Day—No formal class Project Updates Due	**24** Thanksgiving NO CLASS
29 Final Presentations	
~ December 2016 ~	
Tue	**Thu**
	1 Final Presentations
6 Final Presentations	**8** Final Presentations
Project Reports due by 5 pm Friday December 9.	

6 Etiquette and Cheating

Please turn your cellphone to silent before coming to class. It's surprisingly distracting if you sit and text in class—so please don't do it!

Obviously, cheating is not allowed, however I am required by the Dean to remind you. In this class, cheating means passing off someone else's work as your own, whether it is a classmate, a friend, or some author on some paper or blog somewhere. Of course, you may and should discuss you projects with each other and people outside class, but anytime someone makes a substantial contribution you should acknowledge it. Anything you submit should be at least 90% your own work—that means you generate the main argument, you develop the supporting material, and

you write the paper. You may and should ask at least one other person to check the writing for spelling and grammatical errors and ease of reading. If you are confused at all about what is allowed and what is not, please come and see me. If you do an individual homework with another student, please put their name on your homework.

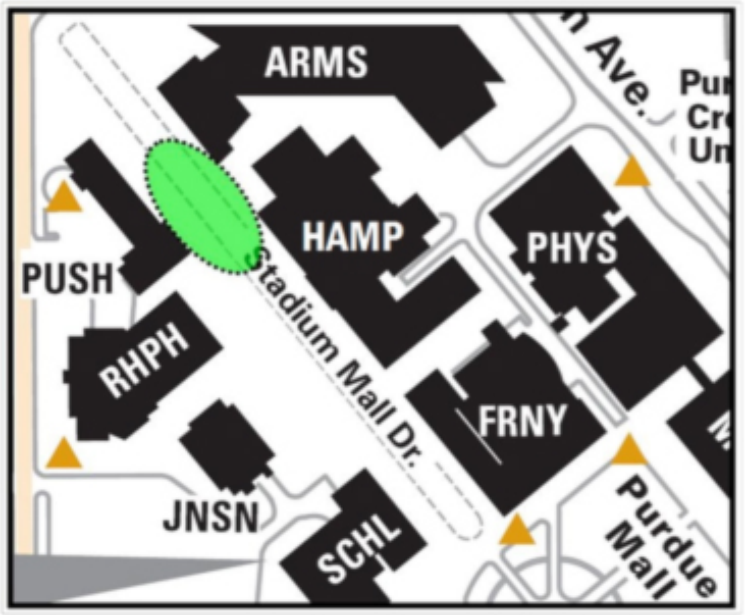
7 Emergency Procedures

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Here are ways to get information about changes in this course:

- Email me or the TA
- Monitor the course site on Blackboard. Lectures and readings will be posted there.

Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let's review the following procedures:

- For any emergency call 911.
- There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.
- If we hear a fire alarm we will immediately evacuate the building. Please gather in the area east of the Purdue University Student Health Center (PUSH) and west of Hampton Hall of Civil Engineering (HAMP) as indicated by the green safe-zone oval shown on the map.
    - **Do not use the elevator.**
    - Here are the evacuation routes.



- If we are notified of a Shelter in Place requirement for a tornado warning we will shelter in the lowest level of this building away from windows and doors. Go to the Basement via any of the stairways.
- If we are notified of a Shelter in Place requirement for a hazardous materials release we will shelter in our classroom shutting any open doors and windows.
- If we are notified of a Shelter in Place requirement for a civil disturbance such as a shooting we will shelter in a room that is securable preferably without windows. Go to the Basement via any of the stairways or the Fieldhouse.

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

- **Indoor Fire Alarms** mean to stop class or research and immediately **evacuate** the building.
  - Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.
- **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.
  - "Shelter in place" means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, a civil disturbance including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

**In both cases, you should seek additional clarifying information by all means possible…Purdue Emergency Status page, text message, email alert, TV, radio, etc…review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html*

EMERGENCY RESPONSE PROCEDURES:

- Review the **Emergency Procedures Guidelines** https://www.purdue.edu/emergency_preparedness/flipchart/index.html
- Review the **Building Emergency Plan** (available on the Emergency Preparedness website or from the building deputy) for:
  - evacuation routes, exit points, and emergency assembly area
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.

EMERGENCY PREPAREDNESS AWARENESS VIDEOS

- "Shots Fired on Campus: When Lightning Strikes," is a 20-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See: http://www.purdue.edu/securePurdue/news/2010/emergency-preparedness-shots-fired-on-campus-video.cfm (Link is also located on the EP website)
- All Hazards Online Awareness training video (on Webcert & Blackboard.) A 30 minute computer based training video that provides safety and emergency preparedness information. See the EP website for sign up instructions.