MME 4316 Failure Analysis

A plane crashes, a bridge collapses, and an automobile goes up in flames. Chances are the experts called in to poke through the wreckage are failure analysts – the engineering experts dedicated to pinpointing what went wrong and how to prevent an encore.

Fall 2016

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Office Hours: MW 9:00-10:00am
TuTh 1:30-3:00pm or **by appointment**
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Text: Metals Handbook Vol. 11, Failure Analysis and Prevention (9th edition). Published by ASM International. [OPTIONAL]

Grade: The course will be divided into thirds and will be tested accordingly. Consider each exam to be equivalent to a 1/3 final exam. There will be no comprehensive final exam, so do well on each exam. Various assignments, related to preliminary-type failure investigations, will be made. Weekly quizzes may be given. Also, each student, as part of an investigative team, will be required to perform an in-depth failure analysis examination on a component with an appropriate professional poster product. These projects will be presented, via a PowerPoint presentation, in an open forum.

Course Content: Failure analysis is a required course in the MME curriculum, which deals with the theoretical and practical aspects of metals and materials failure analysis. Fractures and failed components, when constructively exploited, can be uniquely revealing in the engineering sense. The fracture face of a broken part, for example, often contains a remarkably detailed record of the conditions and events leading to failure. In the case of fatigue, the service record of the part can sometimes be read from the fracture face in a manner similar to the way a forester interprets the growth rings of a tree. Fracture patterns in glass, and in various brittle materials, can also be very revealing as to the origin and progression of the fracture, and thus to its likely cause.

Fundamental to the understanding of design for failure avoidance is an equally thorough understanding of how and why materials, in their fabricated form, fail. The latter understanding is not generally obtainable from studying laboratory fractures of standard specimens produced in a tensile or fatigue test. These fractures are usually quite different from fractures typically found in manufactured parts subject to "real" service environments and load conditions.

The instructional opportunities provided by failed parts are manifold – stress concentrations, welded joints, fatigue, heat treatment condition, design considerations, wear, corrosion, etc. Handling, studying, and analyzing a broken component can give the student a learning experience not readily equaled by any textbook or laboratory exercise. Since the failure normally represents a severe deviation from expected or desired

performance of the component, the lesson learned may have profound and long lasting implications which greatly transcend its purely technical content. In addition, certain aspects of failure analysis as it deals with consulting engineering – particularly examinations, depositions, and trial testimony – will be covered. The instructor welcomes interaction by the students and would invite failures or case studies to be brought to class for discussion.

Course Outline:

Subject	**Recommended Reading**
Introduction	pp.15-32, 75-81
Toughness	pp. 66-71, 57-65
Fracture Mechanics	pp. 47-57
Fatigue*	pp.102-135
Ductile & Brittle Fractures*	pp. 82-101
Corrosion Related Failures*	pp. 245-251, 201-224, 252-262
Wear*	pp. 145-162
Elevated Temperature Failures*	pp.263-297
Fabrication Related Failures*	pp. 344-379, 380-410, 411-419

*to include investigative procedures and general practice and macro- and microfractography utilizing electron microscopy.