



FAILURE ANALYSIS & PREVENTION

project 1

enr 3820

OVERVIEW

The Part I Project will provide an initial learning experience in the collection, analysis, and presentation of physical evidence and background information related to failure. You will get an opportunity to use research and experimentation to test a hypothesis put forth by an expert. The project will also serve as a refresher of laboratory techniques and equipment operation. It's a relatively short and simple project, but I'm hoping the results will provide some fodder for an interesting classroom discussion.

Teams of students will choose to examine either paper clip or light bulb "failures." Your job is to spend one week attempting to verify or refute claims made by experts in well-known, published books. You may use whatever laboratory tools and experimental techniques you believe will provide the best evidence to support your analysis. You should identify reputable literature sources that provide appropriate supporting technical information for your conclusions.

TOPIC 1: LIGHT BULB BURNOUT

Askeland and Phule make the following statement in Chapter 7 of their introductory materials science textbook *The Science and Engineering of Materials*:

You may be aware that incandescent light bulbs contain filaments that are made from tungsten (W). High temperature causing grain growth is one of the factors that causes the filament to fail.

Your goal in this project is to confirm or refute Askeland and Phule's assertion that grain growth is a factor in light bulb filament failure. For either conclusion (confirm or refute), provide supporting evidence for your arguments. If you refute the assertion, you may also provide an alternative hypothesis, if your evidence enables you to do so.

TOPIC 2: PAPER CLIP FAILURE

In his well-known book *To Engineer Is Human*, Henry Petroski starts a chapter with the following paragraph:

When I want to introduce the engineering concept of fatigue to students, I bring a box of paper clips to class. In front of the class I open one of the paper clips flat and then bend it back and forth until it breaks in two. That, I tell the class, if failure by fatigue, and I point out that the number of back and forth cycles it takes to break the paper clip depends not only on how strong the clip is but also on how severely I bend it. When paper clips are used normally, to clip a few sheets of paper together, they can withstand perhaps thousands or millions of the slight openings and closings it takes to put them on and take them off the papers, and thus we seldom experience their breaking. But when paper clips are bent open so wide that they look as if we want them to hold all the pages of a book together, it might take only ten or twenty flexings to bring them to the point of separation.

Your goal in this project is to confirm or refute Petroski's assertion that paper clips, when loaded in this manner, fail by fatigue. For either conclusion (confirm or refute), provide supporting evidence for your arguments. If you refute the assertion, you may also provide an alternative hypothesis, if your evidence enables you to do so.

DELIVERABLES

The deliverables for the Part I project are as follows:

1. Report: Each team should prepare a one page **text-only report** that clearly and succinctly presents your analyses

and conclusions. One page limit does not include your references.

2. Slides: Each team should prepare up to **three PowerPoint slides** to support your analyses and conclusions. We will spend some time in class discussing your findings, and you will use these slides to support your arguments.

ASSESSMENT

Your project experiment, written report, and classroom discussion will be assessed according to the following criteria:

- Qualitative analysis – Are your arguments clear? Are you able to use physical data and researched information to explain technical phenomena and support your conclusions? Do you make appropriate connections among the various technical concepts and information, and between the technical and contextual information? Do you support your data analyses and conclusions with materials science theory? Do you explain discrepancies? Do you make good use of estimation (if appropriate)?
- Quantitative analysis – Are your calculated data accurate? Do you make appropriate use of published information and theory to support your data and quantitative analyses? Do your quantitative results connect to and support your qualitative discussion?
- Communication – Do you make effective use of written communication in the report, and graphical, visual, and oral communication in the presentation and discussion? Is your report well-organized, well-written, and appropriate for the audience? Are the arguments and goals clear, and does the report support these arguments and goals? Are the mechanics (spelling, grammar, word choice, punctuation) well-executed? Do you make logical and well-supported arguments? Do you make good use of graphs and images? Are your slides

clear and professional? Is reference information and evidence carefully woven into the text?

- Diagnosis (Experimental Inquiry) – Are you able to identify pertinent questions in response to the defined project goals? Can you design and implement appropriate experiments to answer the defined questions? Can you identify unexpected results and take corrective action? Are you able to verify the expert's hypothesis, or to form and test your own hypothesis? Are the limitations of the experiment clear, and are suggestions for improvement included?

GRADING RUBRICS

Detailed grading rubrics for this assignment will be posted on the web site. You are encouraged to read these rubrics near the start of the project, and to communicate with the instructor if there are areas of uncertainty. Please use these rubrics for your competency self-assessment.

NOTES ON SELF-DIRECTION

For this project, I provided the problem/guiding question and the goal for the project, but you and your team have a great deal of control in other aspects of the learning process. You will select the particular topics that you think you need to explore to answer the failure question. You will identify the processes whereby you will collect background information, select and implement lab experiments, and analyze your results. You will identify and acquire resources to support your learning and analyses. You will monitor and control your own thought processes, and manage your time and effort. You will control the way in which you interact with your teammates and me. Finally, you will conduct a self-assessment of your competency development, behavioral patterns, teaming interactions, and motivations.