Engineering Ethics Cases with Numerical Problems

from an NSF & Bovay Fund sponsored workshop

August 14-18, 1995

Texas A&M University

Mechanical Engineering Case 3

Specifications for a Conflict

Authors:

William Jordan

(jordan@engr.latech.edu)

Michael A. Latcha

(latcha@oakland.edu)

Suggested Courses:

Mechanical Design, Materials Properites, Strength of Materials

Level:

Sophomore, Junior & Senior

Narrative Part 1

Neal is a metallurgical engineer for Diamond Steel, Inc., a medium-sized but struggling steel company. Diamond Steel's largest client is Maypool Co., the third largest consumer appliance company in the United States. Diamond Steel is currently negotiating a new contract to supply Maypool sheet steel to be used to make the cores for a new design of a basic electric motor used in Maypool appliances. The specifications for the steel were written by engineers at Maypool's Research and Design Center (RDC), which is located 200 miles away from Maypools' Motor Production Facility (MPF) where the motor core plates will be stamped and assembled into appliance motors. The RDC specifications require UNS G10350 steel, rolled to 0.025 inches thick and heat treated to a minimum tensile strength of 1000,000 psi.

In the course of his job at Diamond Steel, Neal has done a considerable amount of business with Maypool's MPF and personally knows several of the technicians who work there. In the process of discussing the upcoming contract, the MPF technicians have told Neal that the MPF presses can only reliably handle steel with Brinell hardness numbers less than 165 without jamming and ruining the workpieces. The MFP technicians suggest to Neal that a steel with a maximum Brinell hardness of 160 will "work just fine" in the motor and be easier to stamp

into motor plates.

Questions Part 1

1. Hardness testing is much faster and cheaper than tensile testing. Due to the shape and size of the indenter, Brinell hardness tests cannot be done on sheet steel of this thickness. Find the appropriate value on the Rockwell 30T scale that Neal should supply to Maypool's Production Department for their own internal quality control tests.

2. Are the specifications supplied by Maypool's RDC and the recommendations of Maypool's MPF in conflict? If so, how serious is the conflict? Should Neal supply steel as specified by the RDC engineers or should he follow the advice of the MPF technicians and supply steel that they can successfully tamp into motor plates? Is there any way he can satisfy both of the RDC and MPF? Explain. Would it be more ethically desirable if he could satisfy both the RDC and the MPF? Explain.

Narrative Part 2:

Based on Neal's calculations, he discovered that UNS G10350 steel with a tensile strength of 100 kpsi (that specified by the RDC engineers) has a Rockwell 30T hardness number of 78 and a Brinell hardness of 200. However, the steel recommended by the MPF technicians with an equivalent Brinell hardness number of 160 has a Rockwell 30T number of 72 and a tensile strength of 80 kpsi. The difference between these two data sets is too great for Neal to see a clear compromise.

The next day, a Friday, Neal decided to travel to the Maypool Research and Design Center to discuss the specifications with the project engineers. They assured him that their specifications are not arbitrary, but rather are based on a target efficiency for the new motor design. He was told that the characteristics of the same steel at a lower hardness would not satisfy the efficiency requirement.

The Maypool engineers also told Neal that the presses at their MPF are rated to process steel with ultimate strengths up to 220 kpsi. It was the opinion of the RDC engineers that the technicians at the Maypool MPF are incompetent. The engineers related several stories of product failures that were traced to improper manufacturing techniques at the MPF.

On his way home, Neal decided to stop ant Maypool's MPF. When questioned, the technicians told him that regardless of how the presses were rated, they have never been able to process steel harder than 165 on the Brinell scale without unacceptable rejection rates. Neal was told that the presses had been recently overhauled by the manufacturer but still did not perform to their original specifications. The technicians then complained to Neal that they have had problems with the RDC engineers over-specifying and over-designing in the past. They again suggested to Neal that he just supply steel that they can easily use - no one would be the wiser and everyone would be happy.

When Neal finally got back to his desk late Friday afternoon, there was a note on his desk form the Diamond Steel Production Manager, Scott, asking for the Rockwell 30T numbers for the Maypool steel contract, which is now scheduled to be signed Monday morning.

Questions Part 2

1. Should Neal supply steel that meets the written specifications of the RDC, knowing that it will probably result

in an unacceptably large rejection rate during production, perhaps raising the cost of the new motors? If he does this, how would it affect the MPF technicians? The RDC engineers implementing the new motor design? Neal's future relationships with the RDC engineers and the MPF technicians? Neal's department at Diamond Steel? Diamond Steel's reputation in the business community?

2. The following are thought provoking questions for use in class: If Neal decides to supply the softer steel that will not produce the designed-for efficiency in the new motors, what possible effect could this have on the operation of the motors and the appliances in which they will be installed? Assume that the rest of the electrical components have also been redesigned to take advantage of the efficiency of the new motor. Consider the effects of Neal's decision on safety, maintenance and the replacement and repair costs of future appliances. Would Neal ever buy another new appliance from Maypool for his own use? Would Neal recommend a Maypool appliance to a friend?

3. Consider the following three models of professional responsibility. The *malpractice model*, the least demanding, requires that an engineer need only perform at a level that meets standards of the profession and applicable laws or codes. More exacting is the *reasonable care model*, where the engineer is expected to consider factors, most often related to safety and quality, that are not explicitly addressed in standards or codes. The *good works modes* sees the engineer investing time and consideration not only beyond what is required, but even beyond what would be reasonably expected. Discuss the options that each one of these models of professional behavior suggest, but that may be necessary to protect the public.

Narrative Part 3

Early Saturday morning, while preparing to play golf, it occurred to Neal that there may be a technical compromise to the problem. Depending on the characteristics of UNS G10350 steel, it may be possible to supply the steel in a soft condition for stamping, followed by heat treating to bring it up to the required tensile strength. However, he knows that the production plant does not have heat treatment facilities, therefore Maypool would have to pay extra to ship the plates to a heat treatment facility after stamping, then ship them back to their MPF for assembly.

Neal played golf that morning with his friend, Ed, a process engineer at a local polymer company. Ed's company is a much bigger supplier to the Maypool MPF than Diamond Steel is. During the round, the subject of the steel specifications in the new contract came up. Ed told Neal that the RDC engineers "have their head in the clouds" concerning technical specifications and new designs. He told Neal story after story of cases where the RDC engineers had to change to conventional designs, with lower grade materials, when their new designs failed to work out in production runs. Ed's advice to Neal was to follow the suggestions of the MPF technicians who actually had to produce the often-flawed designs of the RDC.

When Neal returned home that afternoon, he called Scott, the Diamond Steel Production Manager, at home and told him of the conflict between the Maypool RDC specifications and the recommendations from the MPF technicians. He also outlined his idea of a compromise. Scott reminded Neal that this contract was very important to the financial future of Diamond Steel and that he was not very concerned with the internal strife within Maypool. Scott had no objection to the proposed compromise, as long as the extra cost would not be borne by Diamond Steel. As a result, Scott insisted that Neal say nothing to Maypool until after the contract is signed on Monday morning.

Questions Part 3

1. Additional thought provoking questions for use in class: Is Neal under any personal or professional obligation to suggest technical compromises to Maypool? Consider his obligations to the future customers of Maypool and Diamond Steel, the RDC engineers, the MPF technicians, and his co-workers at Diamond Steel. If so, should these compromises be brought up before or after the contract is signed? Based on your answer, what would be the effect on the MPF technicians? The RDC engineers implementing the new motor design? The consumers who purchase Maypool appliances? Neal? Neal's department at Diamond Steel? Scott? Diamond Steel's reputation in the business community?

Instructor's Note:

The numerical issues of this case are relatively simple. As often happens in engineering practice, the RDC engineers have written specifications in terms of the require tensile strength of the steel, the MPF technicians speak of the capacity of their equipment in terms of the Brinell hardness of the steel to be processed, and the relevant measure for the steel mill is the Rockwell 30T hardness number. Simple conversions between Brinell hardness numbers and tensile strength exist and can be found, among other places, in mechanical design textbooks. Conversions between various hardness tests are found in materials handbooks. Either of these sources can be used to find tabular data on UNS G10350 steel in order to answer Question 1 from Part 3.

Sample Solutions to Ethical Problems

Questions Part 1, Question 2.

The specifications supplied by Maypool's RDC and the recommendations of Maypool's MPF are in conflict with each other. This appears to be a case of internal company conflict and Neal is the middleman Neal **should not** supply steal to meet the MPF's recommendations. He should probably come up with a creative middle way solution to meet his legal and professional obligations to the RDC engineers as well as meet the recommendations of the MPF's. He should go to the engineers and mention that the MPF's are not confident that the steel will work well in their machines. He should get the two groups to talk to each other rather than make him the middle man. This way, he can provide steel that the two parties agree upon.

Questions Part 2, Question 1

Neal is obligated to supply the correct steel which meets the specifications of the RDC engineers. This will have a negative impact on his relationship with the MPF's, but Neal must adhere to the specifications since he cannot predict what would happen to the product's safety if the incorrect steel is used. If the original design is not followed, then all safety calculations done by the RDC engineers for the device will be invalid. Furthermore, it is probably illegal (not to mention a lie of omission) to knowingly provide materials which do not meet the standards of the purchaser.