Specifications for a Conflict: An Engineering Ethics Case Study

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Abstract

This case study is a fictionalized version of an incident witnessed by the first author while working for a steel manufacturing company. The case involves a conflict over the standards used by a steel company in deciding whether or not to ship specific coils of steel to their customer. The conflict ultimately boils down to a choice of loyalty for the steel mill engineer: loyalty to his company, his customer, or to those who will use the final product.

In the scenario presented, a steel mill engineer has to decide whether to ship some coils of steel that are to be used in the cores of electrical motors by a major manufacturer of consumer appliances. He has received minimum strength specifications from the customer's research and design center. The engineer also knows that the presses in the customer's stamping plant cannot reliably handle steel at the required strength. The stamping plant operators have told him that if he keeps the steel hardness below a certain level, the steel can be reliably processed. The engineer seems to be faced with a dilemma: meeting the official specification or supplying steel that actually can be used to make the parts.

Introduction

In the scenario presented, a steel mill engineer has tested some coils of steel that will be used in the core of electrical motors made by a major manufacturer of consumer appliances. He has been given a set of minimum strength standards by the customer's research and design center. However, the engineer also knows that steel that meets these strength standards regularly jams the presses in the customer's stamping plant. The stamping operators have told him that if he keeps the hardness numbers below a certain number, the steel can be easily processed.

The case study is presented in three parts, intended for three separate assignments. In the first part, students need to decide whether there is a conflict between the design center's requirements and the operator's requests. The students must perform some conversions between various hardness ratings and yield strength to determine that a conflict indeed exists.

After they have turned in their responses to part one, the students are given part two. In the second part of the study, the students decide what the engineer should do. The design engineers have indicated they will not change the specifications, which are necessary to achieve a target efficiency in the motor. The engineer appears to have the choice of shipping steel that meets the specifications but will likely jam during manufacture or shipping steel that can be reliably processed but result in an inferior product. To facilitate discussion, the student is asked a series of questions about loyalty: Should the engineer be loyal to the short term or the long term interests of his company? Is there a difference between the two? Are the real customers of the steel mill the appliance designers, the stamping operators, or the appliance consumers?

After the students have turned in their responses to part two, they are given part three. The third part of the study examines the possibility of shipping soft steel that can be easily stamped, then heat treated to increase its strength to the specifications. This stage requires the students to determine the effects of heat treatment on this particular grade of steel. However, even if this alternative is technically possible, who should pay for the added costs of heat treatment?

This engineering ethics case study appeals to engineering students because it involves technical analysis, in contrast to many other engineering ethics problems that are purely qualitative. It also illustrates the complexity of making ethical decisions in the real world. The case is appropriate for courses in materials engineering, manufacturing, or senior design.

Part One

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 the 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 Maypool's 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 100,000 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 work pieces. The MPF 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 for Part One:

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 stamp into motor plates?

Part Two

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 at 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 from 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 for Part Two:

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) Should Neal supply the softer steel that can be reliably processed by the MPF, knowing that they will use it in the new motors regardless of the fact that it will not meet the design specifications? 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?

3) 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? Or for a gift for his mother?

Part Three

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 is Diamond Steel. During the round of golf, 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 for Part Three:

1) Is it possible to satisfy all of the requirements of the appliance company by heat treating the steel after stamping, that is, is Neal's compromise solution technically possible?

2) 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?

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Biography

Michael Latcha has been a faculty member at Oakland University in Rochester, Michigan, since 1986. He teaches in the solid mechanics track of Mechanical Engineering, from introductory statics to senior-level design to graduate dynamics. He received his Ph.D. in 1989 from Wayne State University. His current research includes numerical acoustics and the simulation of multi-body dynamic systems.

William Jordan is an associate professor in the Mechanical and Industrial Engineering Department at Louisiana Tech University. He has obtained B.S. and M.S. degrees in Metallurgical Engineering from the Colorado School of Mines, an M.A. degree in Theology from Denver Seminary, and a Ph.D. in Mechanics and Materials Engineering from Texas A & M University. He is in his twelfth year at Louisiana Tech, and his teaching and research interests focus on the areas of composite materials, fracture mechanics, failure analysis, and engineering ethics. He is a registered professional engineer (Metallurgical Engineering) in the state of Louisiana.