Course: **Date:**

Name:

Ethics in Engineering Case 01:

The Intel Pentium® Chip

Engineers must have an understanding of technical factors involved in making professional and ethical decisions. Here's a brief exercise:

For this assignment, the following pages contain two case studies taken from "Engineering Ethics" by Charles B. Fleddermann[1]. These cases are designed to relate your technical background with identifying and making ethical decisions. In each case, give a thoughtful answer to the questions at the end. Collaboration is allowed (and encouraged), but each student is to turn in answers to the questions individually and their own words.

Before you begin, read through the IEEE Code of Ethics (link) as a standard for ethical behavior as an Electrical or Computer Engineer.

[1]Charles B. Fleddermann, *Engineering Ethics*, 3rd ed. Upper Saddle River: Pearson Prentice Hall, 2008, 27-32.

The Intel Pentium® Chip

In late 1994, the media began to report that there was a flaw in the new Pentium microprocessor produced by Intel. The microprocessor is the heart of a personal computer and controls all of the operations and calculations that take place. A flaw in the Pentium was especially significant, since it was the microprocessor used in 80% of the personal computers produced in the world at that time.

Apparently, flaws in a complicated integrated circuit such as the Pentium, which at the time contained over one million transistors, are common. However, most of the flaws are undetectable by the user and don't affect the operation of the computer. Many of these flaws are easily compensated for through software. The flaw that came to light in 1994 was different: It was detectable by the user. This particular flaw was in the floating-point unit (FPU) and caused a wrong answer when double-precision arithmetic, a very common operation, was performed.

A standard test was widely published to determine whether a user's microprocessor was flawed. Using spreadsheet software, the user was to take the number 4,195,835, multiply it by 3,145,727, and then divide that result by 3,145,727. As we all know from elementary math, when a number is multiplied and then divided by the same number, the result should be the original number. In this example, the result was 4,195,579 [Infoworld, 1994]. Depending on the application, this six-thousandths-of-a-percent error might be very significant.

At first, Intel's response to these reports was to deny that there was any problem with the chip. When it became clear that this assertion was not accurate, Intel switched its policy and stated that although there was indeed a defect in the chip, it was insignificant and the vast majority of users would never even notice it. The chip would be replaced for free only for users who could demonstrate that they needed an unflawed version of the chip [Infoworld, 1994]. There is some logic to this policy from Intel's point of view, since over two million computers had already been sold with the defective chip.

Of course, this approach didn't satisfy most Pentium owners. After all, how can you predict whether you might have a future application where this flaw might be significant? IBM, a major Pentium user, canceled the sales of all IBM computers containing the flawed chip. Finally, after much negative publicity in the popular personal computer literature and an outcry from Pentium users, Intel agreed to replace the flawed chip with an unflawed version for any customer who asked to have it replaced.

It should be noted that long before news of the flaw surfaced in the popular press, Intel was aware of the problem and had already corrected it on subsequent versions. It did, however, continue to sell the flawed version, and, based on its early insistence that the flaw did not present a significant problem to users, seemingly planned to do so until the new version was available and the stocks of the flawed one were exhausted. Eventually, the damage caused by this case was fixed as the media reports of the problem died down and as customers were able to get unflawed chips into their computers. Ultimately, Intel had a write-off of 475 million dollars to solve this problem.

What did Intel learn from this experience? The early designs for new chips continue to have flaws, and sometimes these flaws are not detected until the product is already in use by consumers. However, Intel's approach to these problems has changed. It now seems to feel that problems need to be fixed

immediately. In addition, the decision is now based on the consumer's perception of the significance of the flaw, rather than on Intel's opinion of its significance.

Indeed, similar flaws were found in 1997 in the early versions of the Pentium II and Pentium Pro processors. This time, Intel immediately confirmed that the flaw existed and offered customers software that would correct it. Other companies also seem to have benefited from Intel's experience. For example, Intuit, a leading manufacturer of tax preparation and financial software, called a news conference in March of 1995 to apologize for flaws in its TurboTax software that had become apparent earlier in that year. In addition to the apology, they offered consumers replacements for the defective software.

Questions:

1. Was this case simply a customer-relations and PR problem, or are there ethical issues to be considered as well? If so, what are they?

2. Use the IEEE Code of Ethics to analyze this case and identify all violations (identifying number is ok). Note: pay attention to issues of accurate representation of engineered products and to safety issues.

3. Should you reveal defects in a product to a consumer?
    a. Is the answer to this question different if the defect is a safety issue rather than simply a flaw?

b. Is the answer to this question different if the customer is a bank that uses the computer to calculate interest paid, loan payments, etc., or a hospital that uses the computer to control critical patient care equipment?

4. Should you replace defective projects even if customers won't recognize the defect?

5. Is it ever possible to say that no defect exists in a produce or structure? How thorough should testing be? (Note: use IEEE Code of Ethics as a guide to your answer)

6. Do flaws that Intel found in earlier generation chips have any bearing on these questions? In other words, if Intel got away with selling flawed chips before without informing consumers, does that fact have any bearing on this case? Why or why not?

7. G. Richard Thoman, an IBM senior vice president, was quoted as saying, “Nobody should have to worry about the integrity of data calculated on an IBM machine.” How does this statement by a major Intel customer change the answers to the previous question?

8. Just prior to when this problem surfaced, Intel had begun a major advertising campaign to make Intel a household name. They had gotten computer manufacturers to place “Intel Inside” labels on their computers and had spent money on television advertising seeking to increase the public demand for computers with Intel processors, with the unstated message that Intel chips were of significantly higher quality than other manufacturers’ chips. How might this campaign affect what happened in this case?

9. What responsibilities did the engineers who were aware of the flaw have before the chip was sold? (again, check in with the IEEE Code of Ethics for your response)
    a. After the chips began to be sold?

    b. After the flaw became apparent?

Ethics Assignment Rubric

	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
PROFESSIONAL CODE(S) OF ETHICS			
Student can articulate the primary tenets of the profession's code of ethical conduct.			
Student is familiar with code(s) of ethics and standard(s) of professional practice within the discipline.			
Student can state the application of the code of ethics in the practice of the profession.			
ANALYSIS			
Student is able to recognize an ethical dilemma or issue within the Electrical or Computer Engineering profession.			
Student can identify stakeholders in an ethical dilemma/issue and can demonstrate awareness of differing perspectives of those stakeholders.			
Student is able to recognize and analyze ethical dimensions/complexities of a dilemma.			
Student is able to identify alternative courses of action/solutions regarding an ethical dilemma.			
Student is able to evaluate both immediate and long-term risks/consequences of alternative courses of action.			
Student is able to identify the law(s) relevant to an ethical dilemma and understands what is necessary to comply with the law(s).			
Student can demonstrate understanding of the need for checks and balances in the organization (e.g., internal controls, disclosure requirements).			
OVERALL ASSESSMENT			
Overall, the student exhibits an overall understanding of how to apply ethics to the Electrical or Computer Engineering Profession:			

Modified from: http://www.d.umn.edu/vcaa/assessment/documents/ethicsrubric.pdf