Allowing Defective Chips to Go to Market

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Description

A production-line engineer checks chips for quality control. Ethical issues concerning the handling of defective chips (e.g. whether they should be sold, fixed, or thrown out) are discussed in this scenario; strategies for presenting critical information to superiors are also discussed.

Body

Reference

Introduction

A production line engineer, Shane, checks every chip for quality control (QC). His workers find errors approximately every 150 chips. Either the defective chips must be sent back for repair or they must be axed (thrown away). The manager, Rob, has mandated that workers must axe all defective chips. Rob walks over to Shane's line and declares, "Why some lines sink more dollars into a chip that's failed, I don't understand. We only make 25 cents off of each chip anyway! Spending an *additional* $2.00 per chip will only be more money down the drain. Shane, in our line of work we can't afford to flush money down the toilet."

The following afternoon, Rob calls a meeting in his office. Rob informs Shane, that Shane's line is axing too many chips. "One chip every hundred and fifty is unacceptable! This is becoming a substantial cost to the company. I believe that it would be more beneficial to allow defective chips to go out the door." Shane asks, "What about the defective chips? Won't customers complain?" Rob replies, "Yeah, yeah, but that's not your problem, the company has a return department that will replace them as customers complain." Rob further estimates that allowing defective chips on the market will yield a $416,000 profit for the company.

Facts:

- The line produces 100,000 chips per year.
- Every chip is purchased.
- Chips cost about $9.00 to produce.
- Chip testing costs about $4.00 per chip.
- Chip repair (manpower and material) is about $2.00 per chip.
- This repair cost includes re-testing.
- Profit per chip is $0.25 after testing.
- There are fifteen full-time employees working under Shane.
- Two part-time employees work under Shane's supervision.
- Shane's manager, Rob, has been with the company for about 7 years.
- Shane has been working under the same manager for several years and has had relatively good relations with Rob.

Additional information regarding the Shane's line:

The engineer's line consists of the final inspection between the bond wires, which attach the chips to the prongs and spot plates (the prongs that protrude from the final product), just before the chips are encased in molding compound for final packaging. You may assume that all defects are caused by faulty bond wire attachment and not by any problem with the chip itself, because the chips were tested in the preceding phase before the bond wires were attached.

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Numerical and/or Design Problem(s)

1. What percent of the chips may fail if Xanthum Inc. Orders 15,000 chips from Shane's production line?
2. Do you believe this is an acceptable failure rate? From the perspective of Xanthum? From the perspective of the manufacturer? Why or why not?
3. If Shane's line produces 100,000 chips per year, how much will it cost to:
    1. Test and repair each defective chip?
    2. Test all chips and throw away the defective chips?
    3. Not to test any chips and to replace customers chips as needed?
4. Is Rob's estimate reasonable? What about his assertion that it is cheaper to axe the chips?
5. An additional problem could be added by incorporating combinatorial mathematics to compute time required to test each chip.

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Questions on Ethics and Professionalism

1. What issues are involved in following Rob's recommendation?
2. Is it acceptable to follow Rob's suggested course of action (based on your calculations above)?
3. If Shane has a differing opinion, how could he present his case to Rob?

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Additional Scenario

(To be introduced in lecture after the students have completed the work above on their own.)

The chips ordered by Xanthum, Inc. are to be placed in aircraft navigation units. Shane's boss still believes that the failures are inconsequential. Rob claims, "They always have back-up navigation systems anyway. Besides they fail less than one percent of the time! You should know that -- calculate the percent of chips that will fail."

1. What flaws can be found (based on your previous calculations and present observations) with the superior's argument? Hint: look at the logic used in the quote.
2. Perform a cost/benefit analysis based on the above data. How much will it cost the company in litigation, etc? Make any necessary assumptions such as dollar values for your calculations (as long as your assumptions are not in direct conflict with the stated facts above).
3. How does this scenario influence your response to question 2 from part III?
4. How can Shane constructively present an argument against his superior's opinion?

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Solutions for Numerical Problems

Part I

1. 1/150 chips will not work so: 1/150 = 0.67% will not work.
2. This question in neither right nor wrong. It is meant to provoke thought for later ethical issues.
3.

1. Test all: 100,000 x $4.00 = $400,000 (testing cost)

   Repair cost: 667 bad chips x $2.00 repair cost = $ 1,334

   Profit on repaired chips: 667 bad chips x -$1.75 profit loss = -$1,167.25

   Profit on good chips: (100,000 - 667) x $0.25 = $24,833.25

   Net profit: $24,833.25 - $1,167.25 = $23,666

2. Test all: 100,000 chips x $4.00 profit = $400,000 (testing cost)

   Ax cost: $0.00

   profit on axed chips: 667 bad chips x ($9.00 + $4.00 - $0.25) = -$8,504.25

   Profit on good chips: (100,000 - 667) x $0.25 = $24,833.25

   Net profit: $24,833.25 - $8,504.25 = $16,329

3. There are two polar scenarios based on different student assumptions (and equally correct answers based upon differing assumptions as to the number of chips returned):
   - "Best Case" - no returns of defective chips not test any chips: 100,000 x $4.25 = $425,000
   - "Worst Case" - all defective chips are returned to find the number of chips which actually generate profit:
     - 100,000 - 667 returns = 99,333 - 667 replacements = 98,666 chips to generate dollars
     - Profit from "satisfied" customers: 98,666 x $4.25 = $419,330.5
     - Original profit on the 667 returned chips: 667 x $4.25 = $2,834.75
     - Profit from replacement chips: 667 x -$9.00 = -$6,003
     - Net profit: $419,330.5 + $2,834.75 -$6,003 = 416,162.25

4. Here the student should see that the answer is clearly NO. The manager, Rob, has based his calculation on an improbable event that no chips will be returned. Consequently, his estimate for profit is too high. The manager is also wrong to advocate axing chips; it is profitable if the chips can be repaired, but the line loses money if the chips are axed.

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Solutions to Ethics and Professionalism Questions

1. One major issue in the narrative above is deceiving the public, because the public is sold chips with no precautions taken to ensure their correct assembly. A second issue involved here could be public safety: what if the part is used to build a critical device such as a navigation computer for missiles or airplanes?
2. This answer depends is on the assumption made by the student. If the student perceives this issue as a safety issue, then it would clearly not be acceptable to follow the superior's suggested course of action. Moreover, this answer hinges on whether or not the student perceives this as a management decision or an engineering decision. Again, this is decided by the assessment made by the student: Is this a safety issue? If the welfare of the public will not be compromised then this is decisively an economic decision which falls in the domain of a management. If however, the assumption is made that the chips involve public safety, this falls in the domain of engineering.
3. To present a differing opinion to a manager, it may be necessary to compromise. In this situation, economics can be powerful aid to the engineer. As demonstrated by the above calculations, the manager's estimates were for a best case scenario. Therefore, it can be asserted that actual profits should be less, especially if there is a return cost involved with the defective chips in terms of personnel, paper trails, and loss of reputation. It can be further asserted that by repairing the chips, the loss is significantly minimized in comparison to axing chips: the line is still profitable and the company's reputation for quality could help increase the overall corporate value. So, one creative middle way would be for the engineer to suggest the repair of all chips, and present his calculations to his boss in doing so. This solves the problem of the line losing money, turns a reasonable profit (although nowhere near what could be made via the worst case scenario for the first year), and establishes a tradition of quality within the company.

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Reference

- Jaegar, Richard C. *Introduction to Microelectronic Fabrication.* Addison-Wesley Publishing Co., pp. 153-172 (Fete, 1991).

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Notes

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These problems were originally developed as part of an NSF-funded project to create numerical problems that raise ethical issues for use in engineering and other course assignments. The problems presented here have been edited slightly for clarity.

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Resource Type

Case Study / Scenario

Parent Collection

Numerical & Design Problems With Ethical Content

Topics

Product Liability
Employer/Employee Relationships
Workplace Ethics

Discipline(s)

Engineering
Computer Engineering
Authoring Institution
Zachry Department of Civil Engineering-TAMU Ethics