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CS4515
HW1

Exercise 1.2: Chip costs and fabrication

[20/20/20/20] <1.6> They will sell a range of chips from that factory, and they need to decide how much capacity to dedicate to each chip. Imagine that they will sell two chips. Phoenix is a completely new architecture designed with 7 nm tech-nology in mind, whereas RedDragon is the same architecture as their 10 nm Blue-Dragon. Imagine that RedDragon will make a profit of $15 per defect-free chip. Phoenix will make a profit of $30 per defect-free chip. Each wafer has a 450 mm diameter.

a. [20] <1.6> How much profit do you make on each wafer of Phoenix chips?

First we must find the number of dies per wafer:

$$Dies\ per\ Wafer = (\pi \times (Wafer\ diameter/2)^2/Die\ area) - (\pi \times Wafer\ diameter/\sqrt{(2 \times Die\ area)})$$

Given that the Wafer diameter is 450mm, and the Die size is 200mm^2 we can use the above equation to calculate the number of Dies per Wafer.

$$Dies\ per\ Wafer = (\pi \times (45/2)^2/2.00) - (\pi \times 45/\sqrt{(2 \times 2.00)})$$

Dies per Wafer = 795.2156 – 70.6858 ~= 724 Dies per Wafer

We then calculate the Yield:

$$Die\ yield = Wafer\ yield \times (1/(1 + Defects\ per\ unit\ area \times Die\ area)^N)$$

OR

$$Die\ yield = (1 + (Defects\ per\ unit\ area \times Die\ area/Wafer\ yield))^{-N}$$

Wafer Yield is not told to us explicitly in this case so based on p33 of the texbook:
“Wafer yield accounts for wafers that are completely bad and so need not be tested. For simplicity, we’ll just assume the wafer yield is 100%.” - Computer Architecture: A Quantitative Approach Sixth Edition, J. Hennessy, D. Patterson. page 33.

The other information is told to us directly in Figure 1.26.

$$Die\ yield = (1 + (0.04 \times 2.00/1))^{-14}$$

Yeild ~= 0.34

Finally we can calulate profit using the following equation:

Profit = $30 * 0.34 * 724 = $7394.81 per good chip

b. [20] <1.6> How much profit do you make on each wafer of RedDragon chips?

Using the equations from the previous problem we can substitute the proper values for RedDragon

$$\textit{Dies per Wafer} = (\pi \times (45/2)^2/1.20) - (\pi \times 45/\sqrt{(2 \times 1.20)}) \quad \sim= 1234$$

$$\textit{Die yield} = (1 + (0.04 \times 1.20/1))^{-14} \quad \sim= 0.52$$

Profit = $15 * 0.52 * 1234 = $9625.2

c. [20] <1.6> If your demand is 50,000 RedDragon chips per month and 25,000 Phoenix chips per month, and your facility can fabricate 70 wafers a month, how many wafers should you make of each chip?

RedDragon: 50,000/1234 ~= 40.5 wafers needed
Pheonix: 25,000/724 ~= 34.5 wafers needed

Because RedDragon produce more profit, it would be best to provide their full demand. Therefore we should produce **40 RedDragon wafers and 30 Pheonix wafers**.