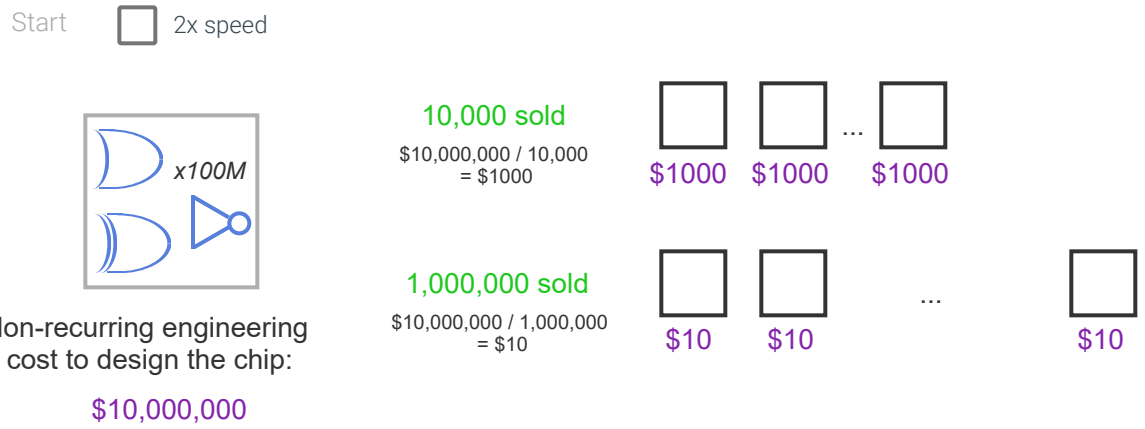
8.2 Chip economics

High NRE cost encourages mass-production

A ***chip*** (aka ***integrated circuit*** or ***IC***) is a digital circuit manufactured on a fingernail-sized piece of silicon, typically placed inside a black or silver insulating package.

Non-recurring engineering (or ***NRE***) cost is the cost to design and set up a computer chip for manufacturing. Due to the complexity of modern chips having billions of transistors, NRE costs may be tens or hundreds of millions of dollars. That cost adds to a chip's cost, depending on the number of chips made. Ex: NRE cost for a chip may be $10,000,000. If 10 made, $10,000,000/10,000 = $1000 needs to be added per chip to cover NRE cost. But if 1,000,000 chips are made, only $10,000,000/1,000,000 = $10 need be added. Thus, mass-producing a chip allows for lower chip costs, since NRE cost can

PARTICIPATION ACTIVITY 8.2.1: High NRE cost favors mass-producing chips.



PARTICIPATION ACTIVITY 8.2.2: NRE and mass-produced chips.

Assume NRE cost is evenly distributed among chips sold.

1) NRE cost for a given chip is $10 million. If 1 million chips are sold, how much is added per chip to cover NRE cost?

Check Show answer

2) NRE cost for a given chip is $10 million. If 10 million chips are sold, how much is added per chip to cover NRE cost?

Check Show answer

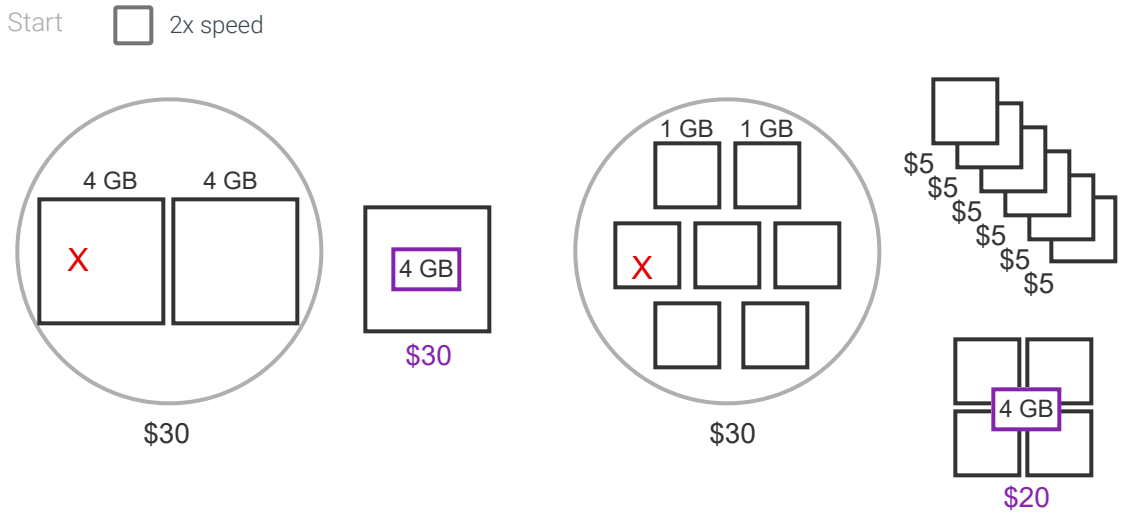
3) A chip maker currently sells a 128 MB chip for $10. A customer wants 10,000 256 MB chips for $50 per chip. The NRE cost for designing a 256 MB chip will be $10 million. Should the chip maker design a new 256 MB chip for the customer? Type yes or no.

Check Show answer

Low yield of large chips encourages smaller chips

The chip manufacturing process simultaneously creates multiple identical chips on a silicon wafer (a round silicon slice), a chip is cut out. The manufacturing process may take hours or days and is costly. Unfortunately, a wafer may have defects, wire, that render some chips unusable. ***Yield*** is the percentage of chips that are usable and free from significant defects. Ex chips on a wafer are usable, yield is 40/50 = 80%. Larger chips are more likely to enclose a defect and thus have lower yield

PARTICIPATION ACTIVITY 8.2.3: Smaller chips are less likely to enclose a defect, giving higher yields, and ultimately lower cost.



For learning purposes, this section shows only a few chips per wafer. However, a real wafer may fit hundreds or even thous

PARTICIPATION ACTIVITY 8.2.4: Yield.

Assume wafer manufacturing cost is evenly distributed among usable chips. Ex: If the wafer manufacturing cost is $50 and a wafer has 10 usable chips, the cost is $50 / 10 = $5 per chip.

1) A wafer holds 50 chips and costs $100.

What is the cost per chip, assuming all chips are usable?

Check Show answer

2) A wafer holds 50 chips. 10 defects appear on the wafer, making 5 chips unusable. How many usable chips result?

Check Show answer

3) A wafer holds 50 chips. 20 defects cause 15 to be unusable. What is the yield? Answer as: 50%

Check Show answer

4) An $80 wafer holds 50 small chips. 10 defects cause only 40 chips to be usable (80% yield). What is the wafer cost per usable chip?

Check Show answer

5) An $80 wafer holds 20 large chips. 10 defects cause only 10 chips to be

usable (50% yield). What is the wafer cost per usable chip?

Check Show answer

6) If a wafer just holds one massive chip, and any defect renders a chip unusable, how many defects can be tolerated?

Check Show answer

Example 8.2.1: Memory card composed of multiple memory chips.

If one looks inside a computer, one is likely to find memory chips arranged in an array to form a larger memory (described in another section). Below is a memory card from a personal computer, with 16 4 Gb chips (8 on each side of the card). Those 16 chips form a 16*4 = 64 Gb memory, meaning an 8 GB memory. Building a larger memory by composing smaller memory chips is more economical, as described above.

Provide feedback on this section