ECEN 248 – Introduction to Digital Systems Design (Spring 2008) (Sections: 501, 502, 503, 507)
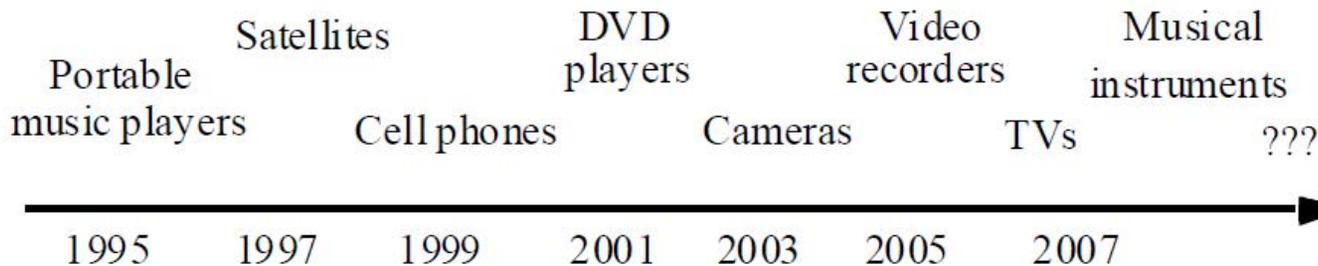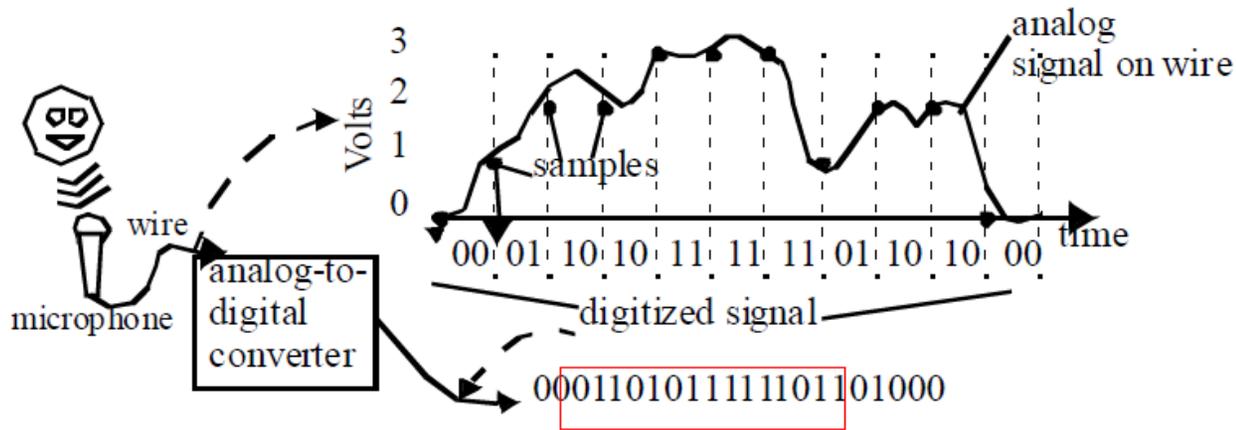
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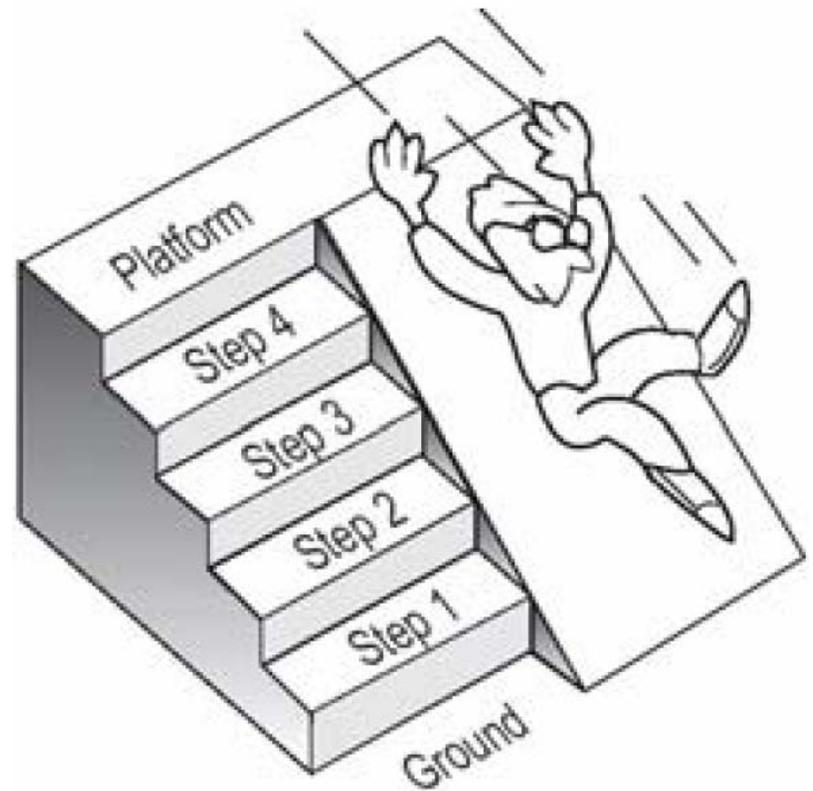http://dropzone.tamu.edu/~xizhang/ECEN248

Analog & Digital Signals

- More and more analog products are becoming digital.

Analog V.S. Digital

- Analog
  - Continuous
  - E.g., Radio Antenna on Cell Phone
- Digital
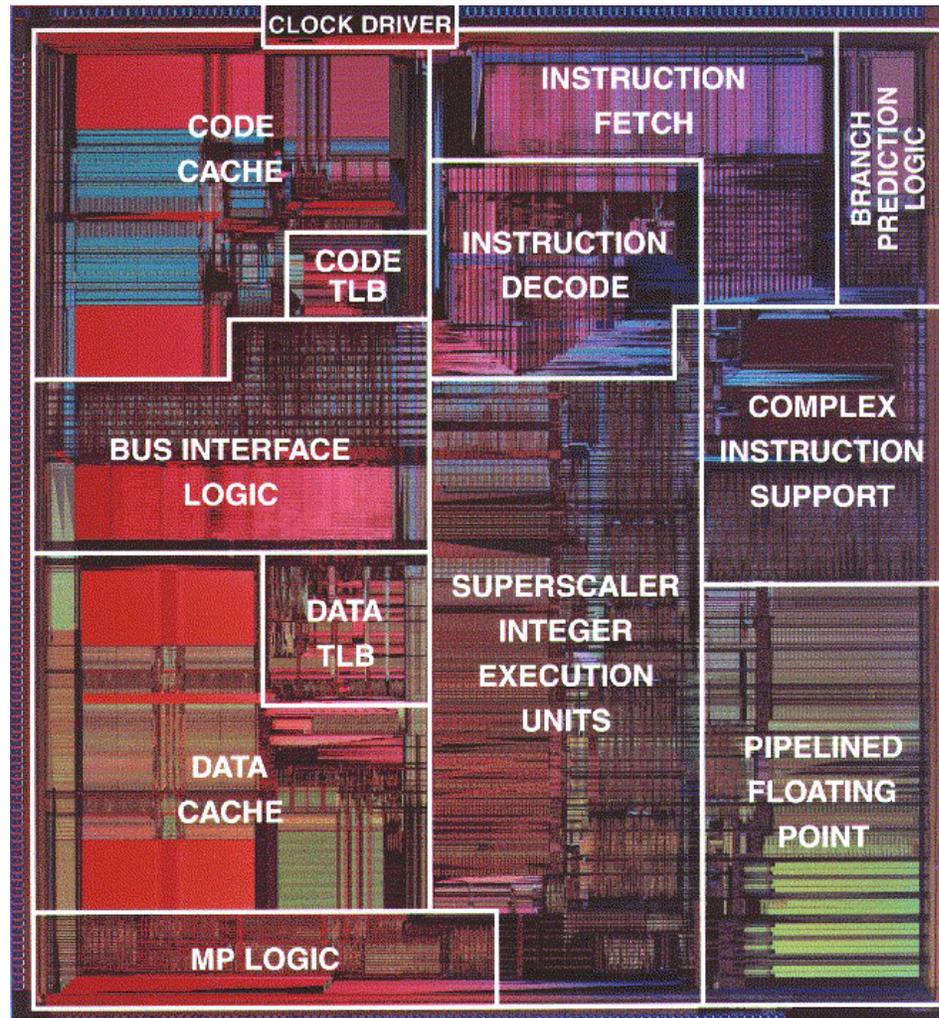 - Discrete
  - E.g., Pentium Processor

Integrated Digital Circuits

- Jack Kirby, a former professor of this department, invented Integrated Circuits in 1959 at Texas Instruments.

- He argued that by putting all electronic components into a single die, performance would increase and cost would decrease.
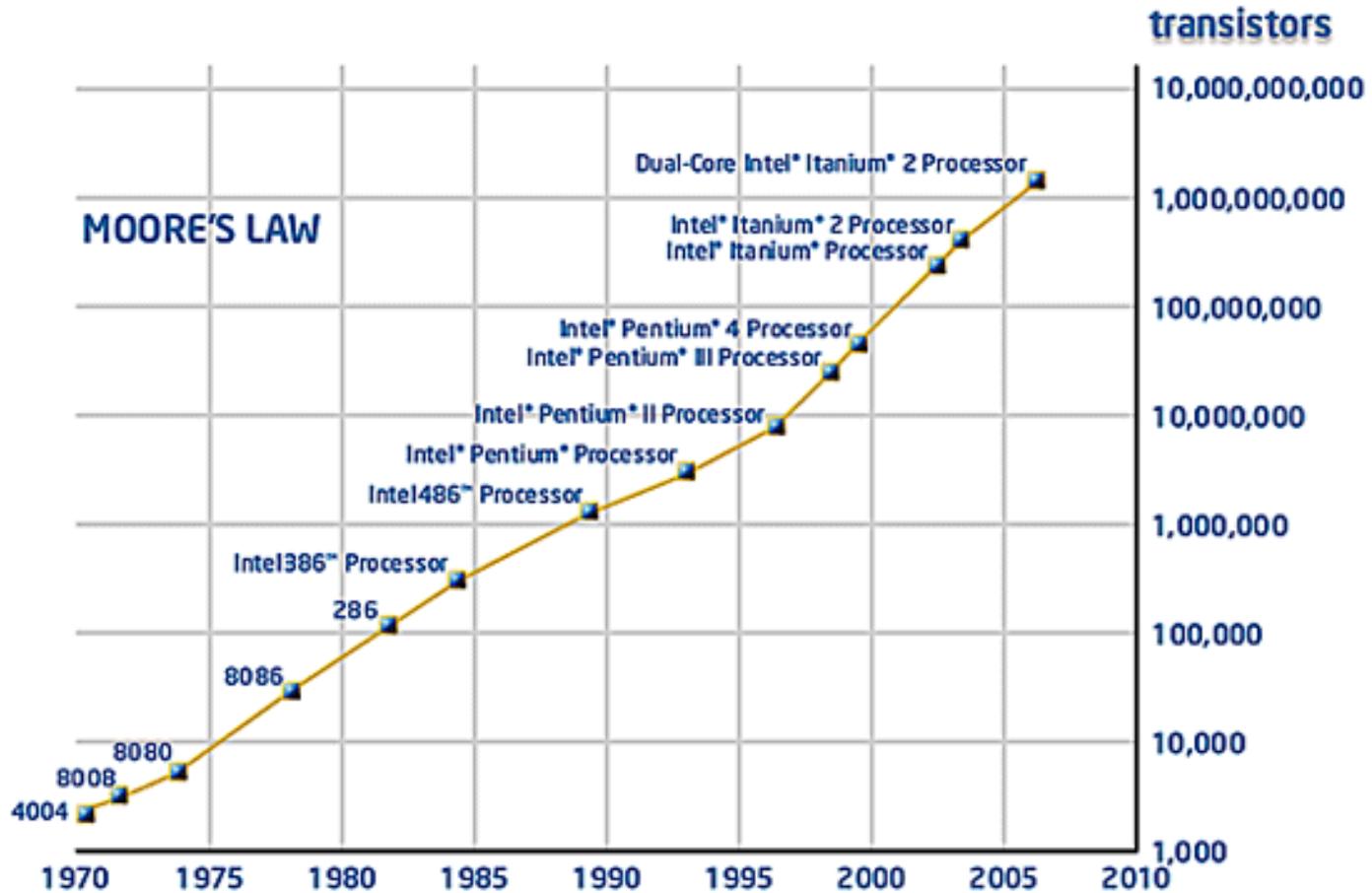
Silicon Wafer

Individual IC (die)
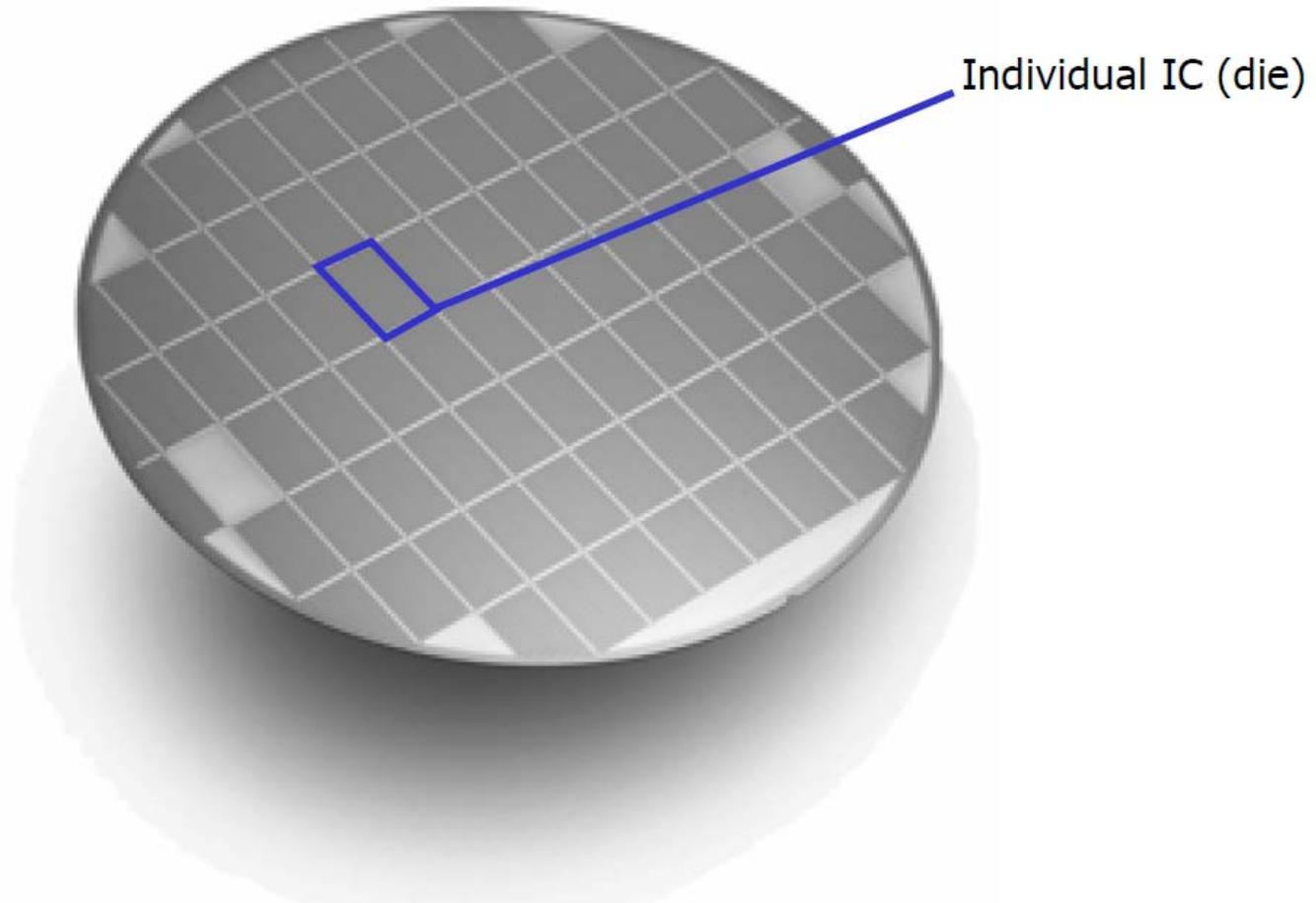
Pentium Die Photo

Moore's Law

- Gordon Moore: co-founder of Intel.
  - Predicted that number of transistors per chip would grow exponentially (double every 18 months).
  - Exponential improvement in technology is a natural trend: steam engines, dynamos, automobiles.

- Today, the price of a transistor is less than a grain of rice

Moore's Law (cont'd)

Moore's Law (cont'd)

What of the following is the largest (in terms of number of transistors)?

A) Pentium 4 Extreme Edition

B) Xilinx FPGA

C) Geforce 6800 Ultra

Answer:

A) Pentium 4 Extreme Edition (178 million)

B) Xilinx FPGA (1 billion)

C) Geforce 6800 Ultra (222 million)

What is Logic Design?

- Given a specification, derive a solution using available electronic components
- Meeting criteria for performance, cost, power, reliability, etc
- Design verification checks if the design is correct in terms of function and performance
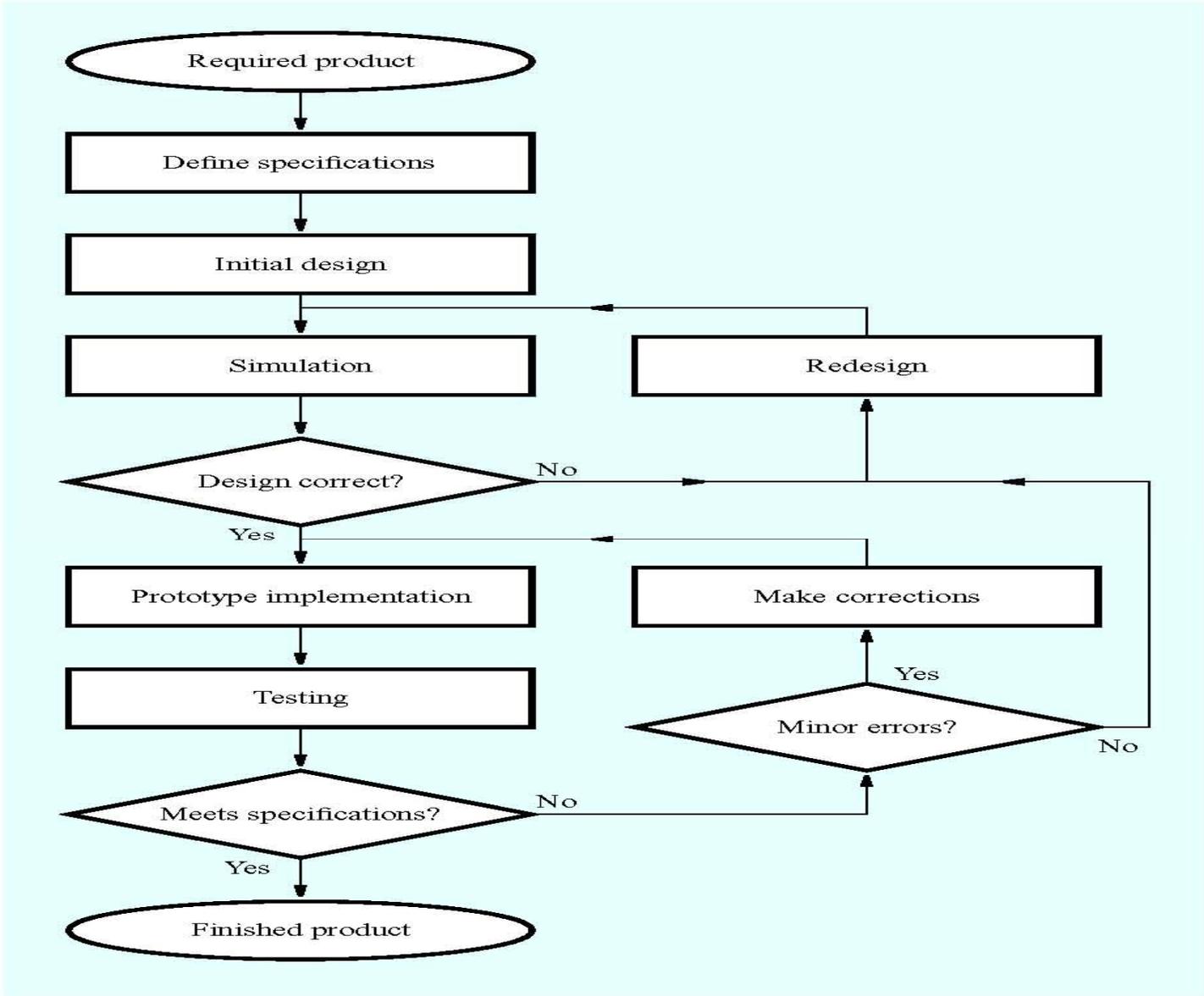- Design optimization transforms a lousy design to one with better quality
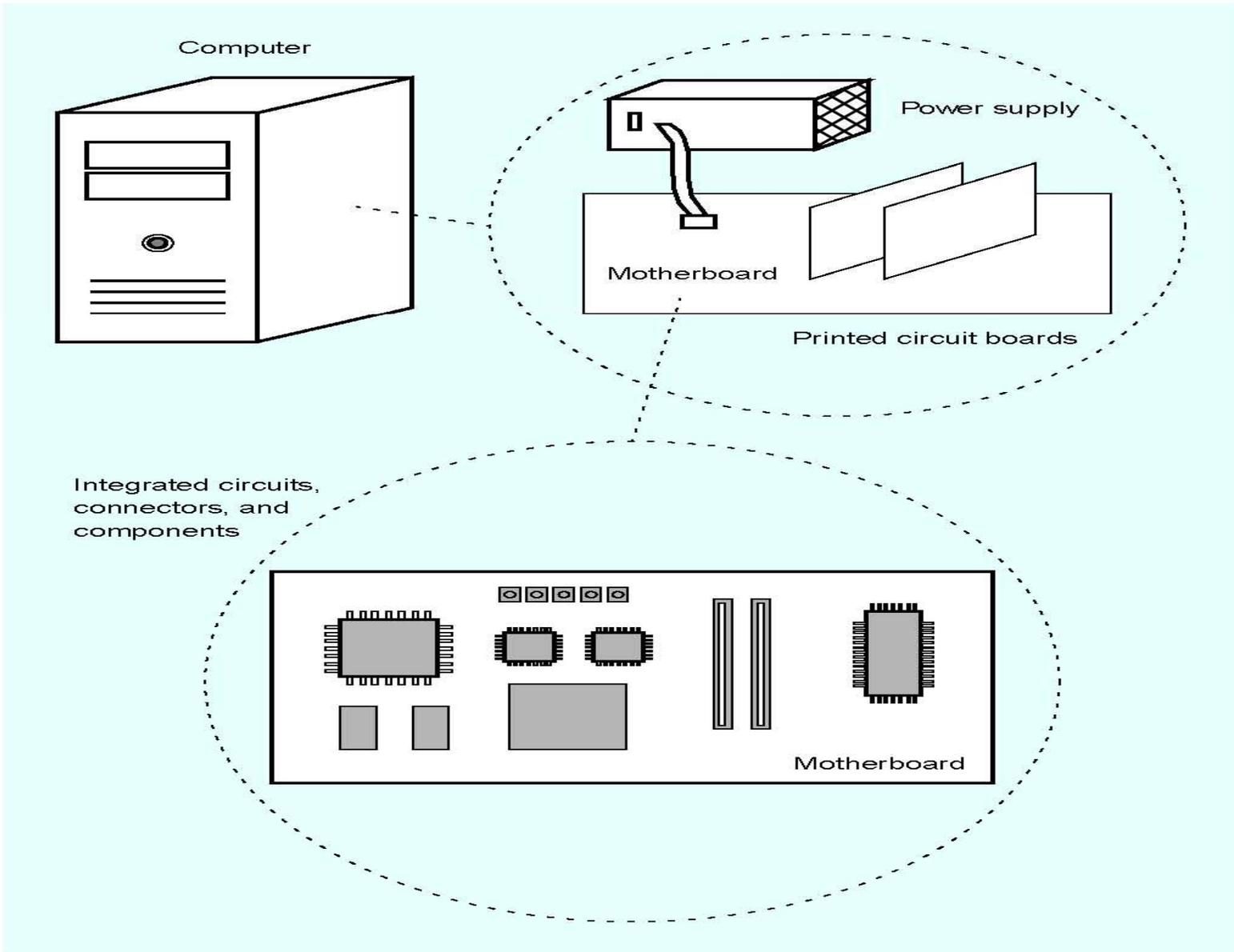
Figure 1.3. The development process.
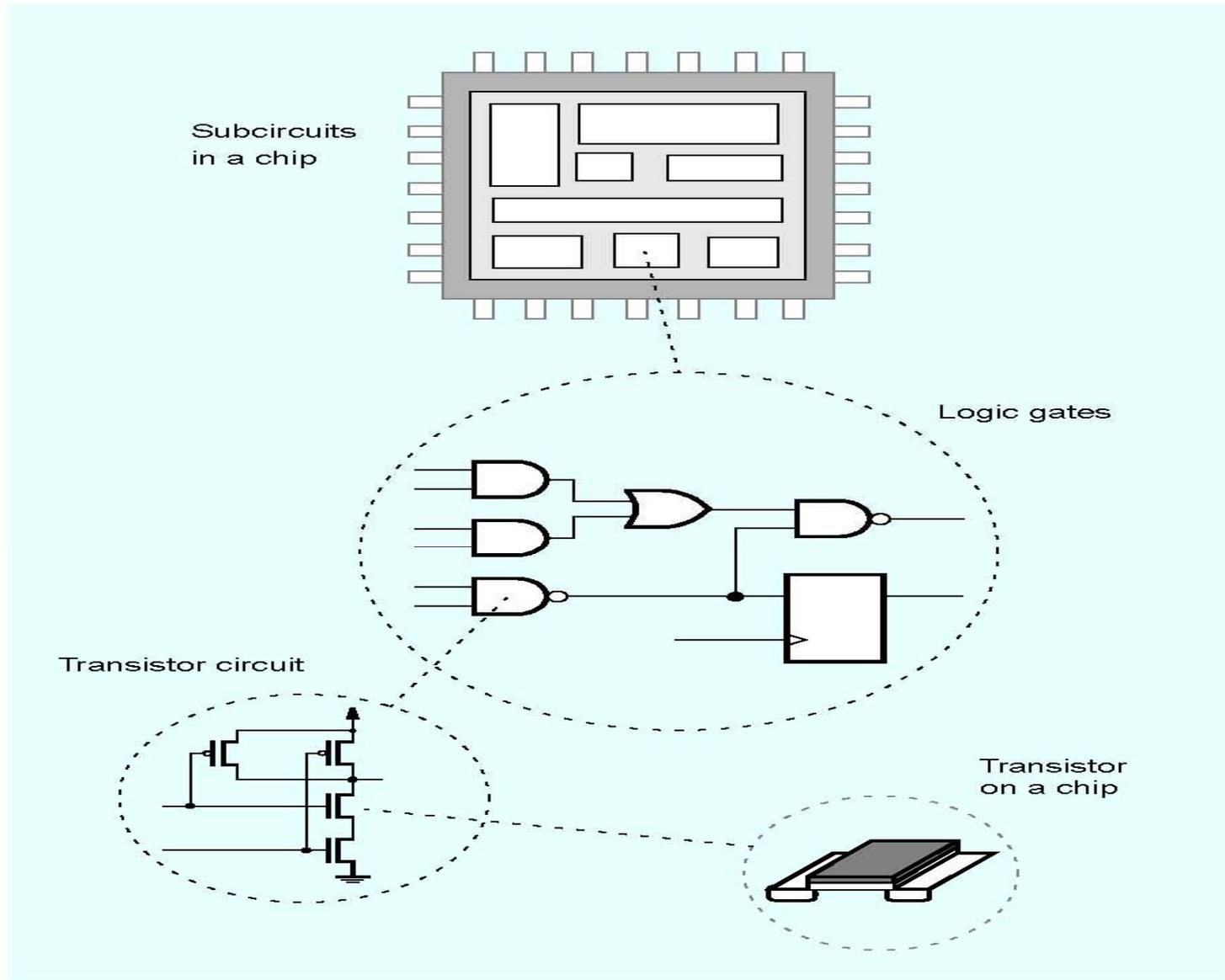
Figure 1.5. A digital hardware system (Part *a*).

Subcircuits
in a chip

Logic gates

Transistor circuit

Transistor
on a chip

Figure 1.5. A digital hardware system (Part *b*).

Boolean Algebra

- Number systems: Unary, binary, decimal, dozenal, bidecimal, ...
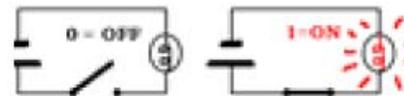- Binary system (0 and 1): Historical Perspective

Boolean algebra (mid-1800s)

Boole's intent: formalize human thought

Switches (1930s)

For telephone switching and other electronic uses

0 = OFF   1 = ON

Shannon (1938)

Showed application of Boolean algebra to design of switch-based circuits

Digital design