A BRIEF LOOK AT SEMICONDUCTOR TECHNOLOGY

The final digital product is

- A new chip (IC) ➔ A new PCB
  - Which gates & FFs and how many of them? ➔ Depend on ➔ Which chips and how many chips?
  - Operation (purpose) and speed, cost, power, size, weight, reliability, compatibility, upgradability, etc. of the digital product

Switches (IC transistors) ➔ Implement ➔ Gates and FFs ➔ Implement ➔ Digital circuits ➔ on ➔ Chips ➔ on PCBs

IC transistors resistors, capacitors, diodes, etc ➔ Implement ➔ Gates and FFs ➔ have ➔ Determine ➔ Speed, cost, power, size, weight, reliability, compatibility, upgradability, etc. characteristics

➢ Therefore, we also need to study technology

⇒ Substances used for IC transistors, resistors, capacitors, diodes, etc.
⇒ Digital electronic circuits that use IC transistors, resistors, etc. and implement gates and FFs

Comparison of commonly used substances and digital electronic circuits for chips with respect to chip density
Transistor-Transistor Logic (TTL) features

- TTL families: 7400 series: 74 (Standard), 74H (High speed), 74L (Low-power), 74S (Schottky), 74LS (Low-power Schottky), 74AS (Advanced Schottky), 74ALS (Advanced Low-power Schottky), 74F (Fast)
- Unused gate inputs: can be left unconnected (floating), but should be tied to a used input to be safe. Also, can connect to 1 or 0 depending on the input characteristic, via a pull-up resistor or pull-down resistor, respectively
- Gate output circuits:
  - Totem-pole (do not short circuit gate outputs)
  - Tri-state (gate outputs can be short circuited if only one gate is enabled)
  - Open-collector (an external pull-up resistor needed. Gate outputs can be short circuited)

Complementary Metal Oxide Semiconductor (CMOS) features

- High-density CMOS chips: Microprocessors, graphics processors, DRAMs, SRAMs, etc.
- Low-density CMOS chips: 4000 series; 7400 series: 74HC (High-speed CMOS), 74HCT (High-speed CMOS, TTL compatible), 74AC (Advanced CMOS), 74ACT (Advanced CMOS, TTL compatible), 74FCT (Fast CMOS, TTL compatible), 74FCT-T (Fast CMOS, TTL compatible with TTL V<sub>OH</sub>)
- Unused gate inputs: do not leave them unconnected (floating). Tie them to a used input. Also, can connect to 1 or 0 depending on the input characteristic, via a pull-up resistor or pull-down resistor, respectively
- Gate output circuits:
  - Regular (do not short circuit gate outputs)
  - Tri-state (gate outputs can be short circuited, if only one gate is enabled)
  - Open-drain (an external pull-up resistor needed. Gate outputs can be short circuited)
- Electrostatic discharge can damage CMOS chips. Unless properly grounded, one should not touch CMOS chips