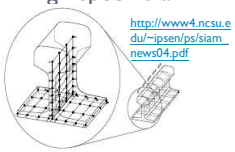
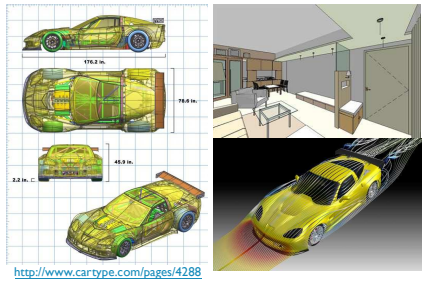
# Computer-aided design

## What is CAD?

- Using computer technology for the process of design.
- Examples:
  - Building interior-design
  - Automotive
  - High-speed train

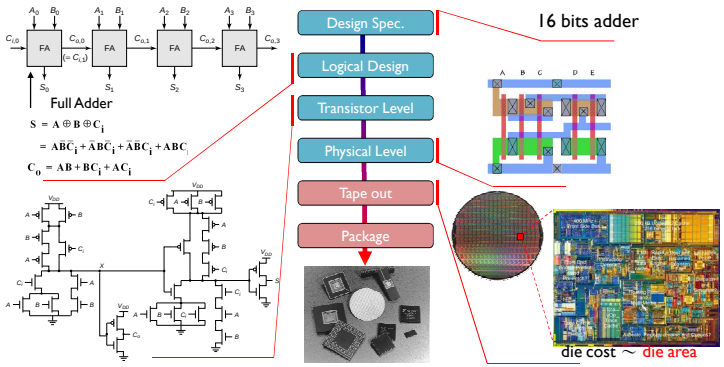



  - Many more: aircraft, and aerospace industries, industrial and architectural design, …
  - We will focus on EDA(Electronic Design Automation)

## EDA (Electronic Design Automation)

- IC design flow



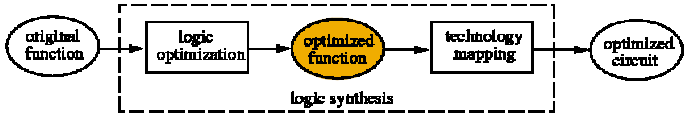







- From Wai Kei Mak's lecture note

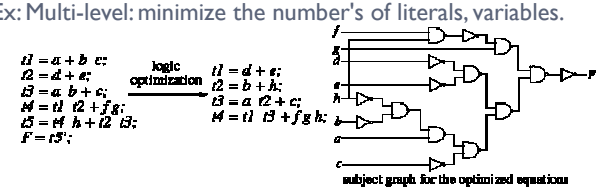
## Logical design/synthesis




- Optimization goals: minimize area, delay, power, etc
  - Ex: Two-level: minimize the number of product terms.

$$F = \bar{x}_1\bar{x}_2\bar{x}_3 + \bar{x}_1\bar{x}_2x_3 + x_1\bar{x}_2\bar{x}_3 + x_1\bar{x}_2x_3 + x_1x_2\bar{x}_3 \Rightarrow F = \bar{x}_2 + x_1\bar{x}_3.$$

  - Ex: Multi-level: minimize the number's of literals, variables.

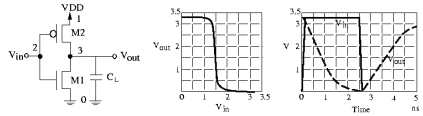



- 邏輯設計，離散數學，演算法

## Transistor-level design

- Switch-level simulation (treats transistors as switches)
- Circuit simulation or transistor-level simulation (most detailed analysis)
  - Ex: Circuit Simulation of a CMOS Inverter (0.6 μm)

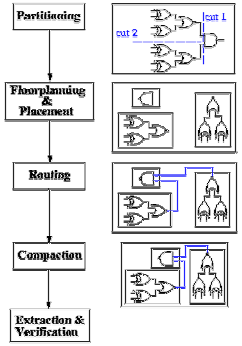
```
M1 3 2 0 0 nch W=1.2u L=0.6u AS=2.16p PS=4.8u AD=2.16p PD=4.8u
M2 3 2 1 1 pch W=1.8u L=0.6u AS=3.24p PS=5.4u AD=3.24p PD=5.4u
CL 3 0 0.2pF

VDD 1 0 3.3
VIN 2 0 DC 0 PULSE (0 3.3 0ns 100ps 100ps 2.4ns 5ns)

.LIB '../mod.06' typical

.OPTION NOMOD POST INGOLD=2 NUMDGT=6 BRIEF
.DC VIN 0V 3.3V 0.001V
.PRINT DC V(3)
.TRAN 0.001N 5N
.PRINT TRAN V(2) V(3)
.END
```




- 物理，電子電路，線性代數，演算法

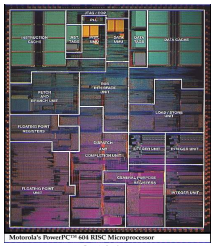
## Physical (layout) design

- Physical design converts a circuit description into a geometric description.
  - The description is used to manufacture a chip.
- Physical design cycle:
  - Logic partitioning
  - Floorplanning and placement
  - Routing
  - Compaction
- Others: circuit extraction, timing verification and design rule checking.

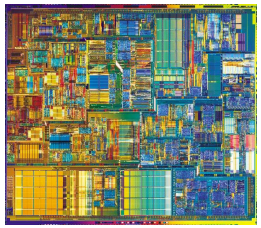



- 演算法，計算幾何演算法，最佳化

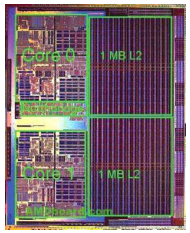
## Examples



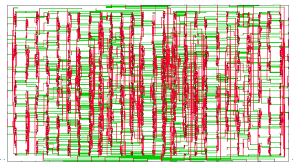

PowerPC 604 Floorplan



Pentium 4 Floorplan




AMD dual core



Routing Example
0.18um technology,
pitch = 1 um, 2774 nets.