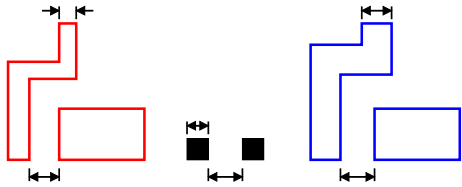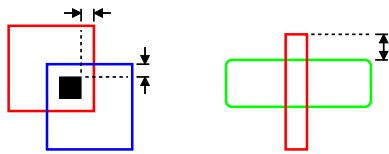# Design Rules

To prevent chip failure, designs must conform to design rules:

- Single layer rules
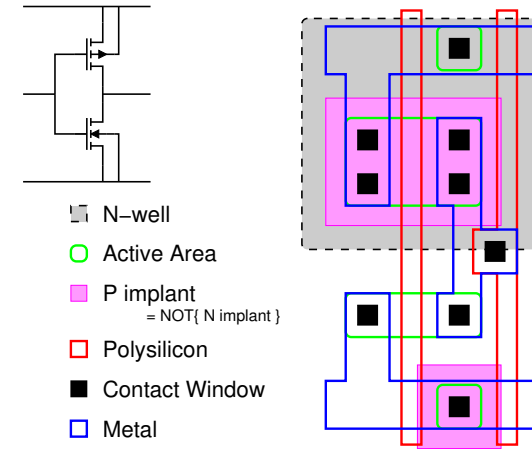

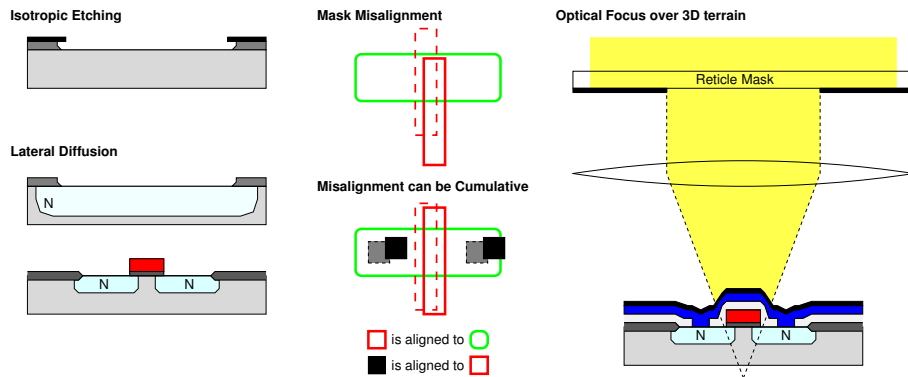- Multi-layer rules

5001

Design Rules

0.5 μm CMOS inverter

- N–well
- Active Area
- P implant
  = NOT{ N implant }
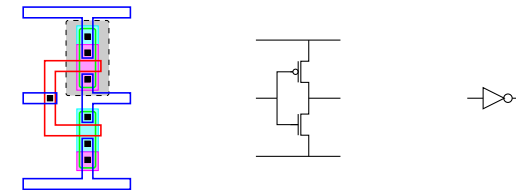- Polysilicon
- Contact Window
- Metal

5003

Derivation of Design Rules

Isotropic Etching

Lateral Diffusion

Mask Misalignment

Misalignment can be Cumulative

is aligned to

is aligned to

Optical Focus over 3D terrain
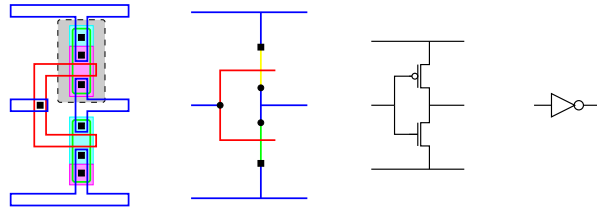
Reticle Mask

5002

Abstraction

Levels of Abstraction

- Mask Level Design
  - Laborious Technology/Process dependent.
  - Design rules may change during a design!
- Transistor Level Design
  - Process independent, Technology dependent.
- Gate Level Design
  - Process/Technology independent.

5004

Abstraction - Stick Diagrams

Stick diagrams give us many of the benefits of abstraction:

- Much easier/faster than full mask specification.
- Process independent (valid for any CMOS process).
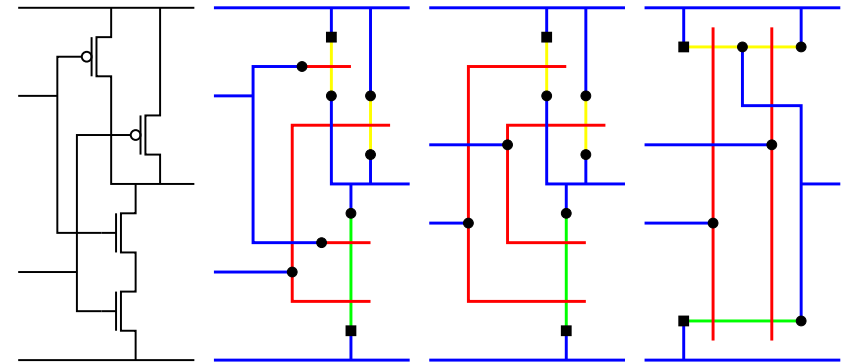- Easy to change.

while avoiding some of the problems:

- Optimized layout may be generated much more easily from a stick diagram than from transistor or gate level designs.[1]

_____

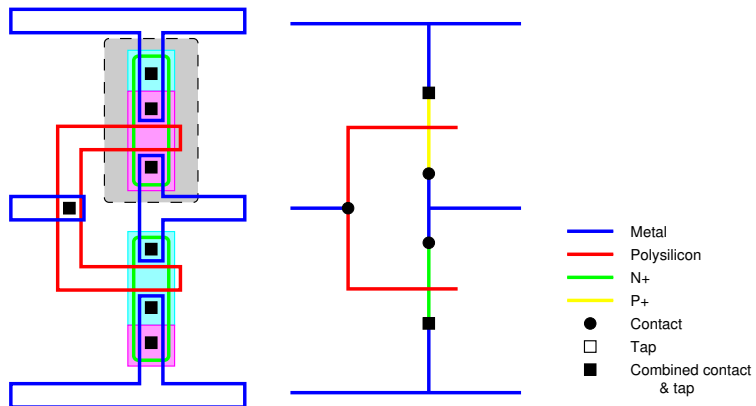[1] note that all IC designs must end at the mask level.

Digital CMOS Design
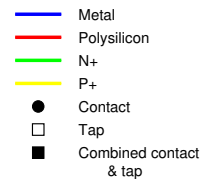
Stick Diagrams

Digital CMOS Design

Stick Diagrams

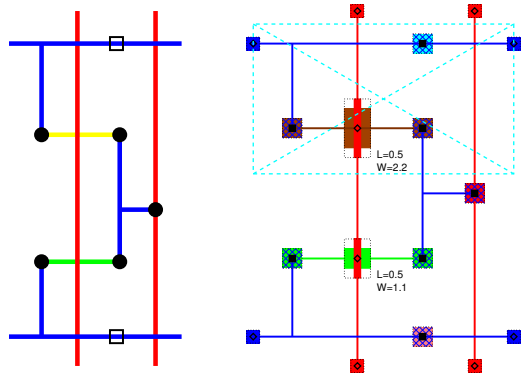|	
Metal	
Polysilicon	
N+	
P+	
●	Contact
☐	Tap
■	Combined contact & tap

Digital CMOS Design

Stick Diagrams

- *Explore your Design Space.*

  - Implications of crossovers.

  - Number of contacts.

  - Arrangement of devices and connections.

- Process independent layout.

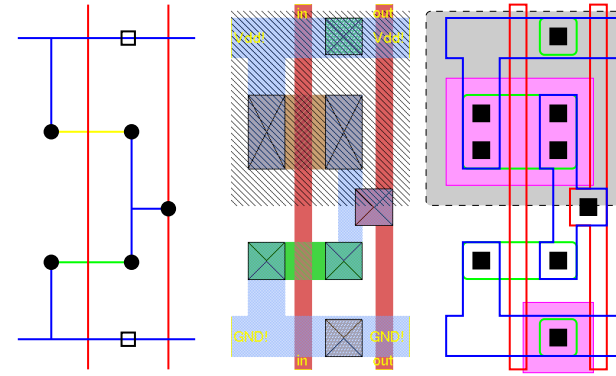- Easy to expand to a full layout for a particular process.

Sticks and CAD - Symbolic Capture

L=0.5
W=2.2

L=0.5
W=1.1

- Transistors are placed and explicitly sized.
  - components are joined with zero width wires.
  - contacts are automatically selected as required.
- A semi-automatic compaction process will create DRC correct layout.

Sticks and CAD - Magic

- Log style design (sticks with width) - DRC errors are flagged immediately.
  - again contacts are automatically selected as required.
- On-line DRC leads to rapid generation of correct designs.
  - symbolic capture style compaction is available if desired.