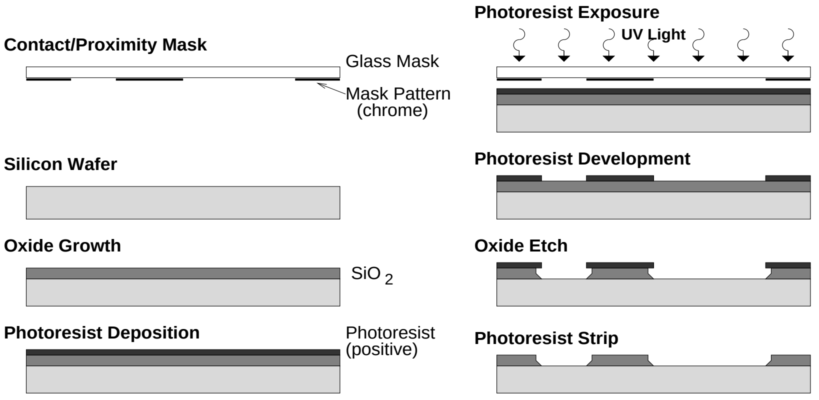
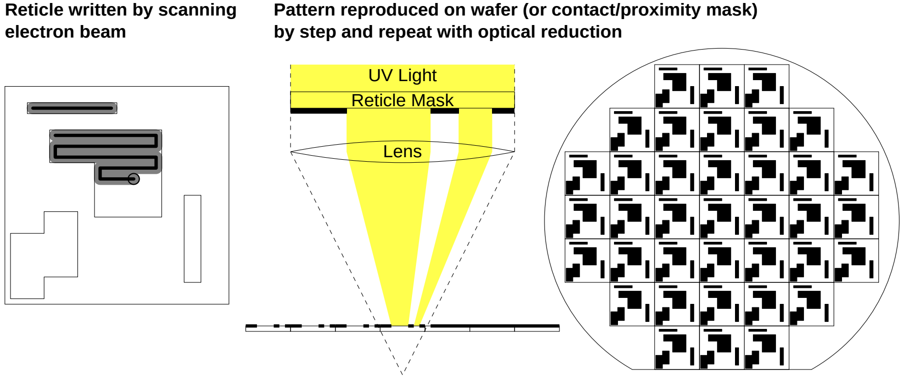
Photolithography



Mask Making

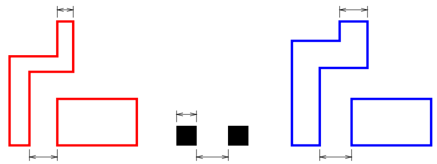


- Optical reduction allows narrower line widths.

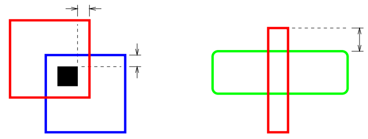
Design Rules

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

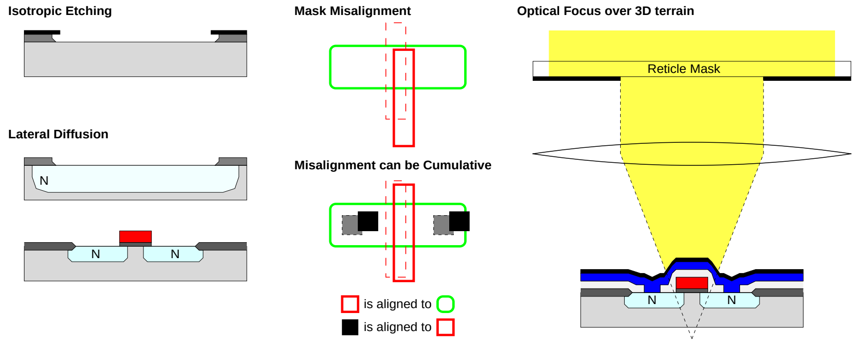
- Single layer rules



- Multi-layer rules

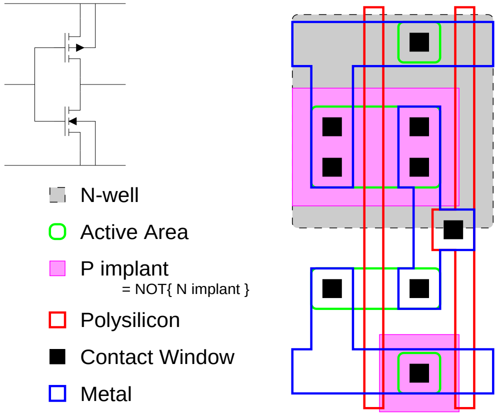


Derivation of Design Rules



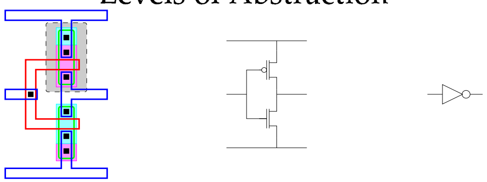
Design Rules

0.5 μm CMOS inverter



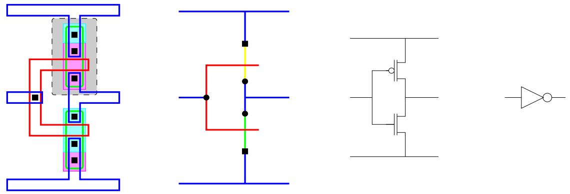
Abstraction

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.

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.

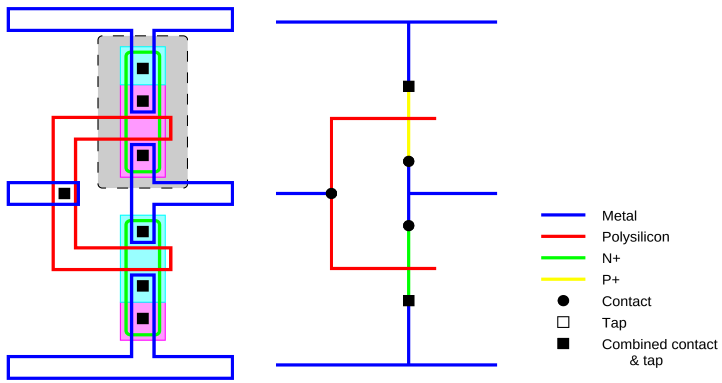
while avoiding some of the problems:

- 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.

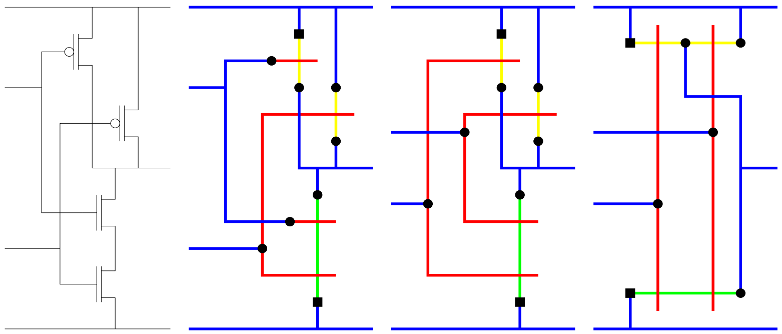
Digital CMOS Design

Stick Diagrams



Digital CMOS Design

Stick Diagrams

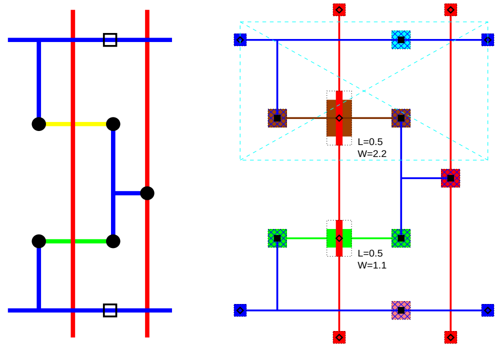


Digital CMOS Design

Stick Diagrams

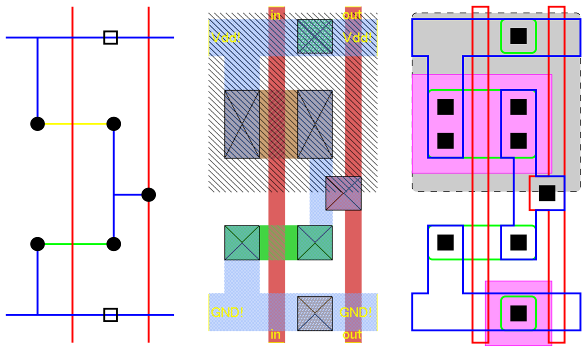
- *Explore your Design Space.*
  - Implications of crossovers.
  - Number of contacts.
  - Arrangement of devices and connections.
- Process independent layout.
- Easy to expand to a full layout for a particular process.

Sticks and CAD - Symbolic Capture



- 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.