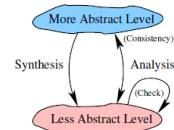
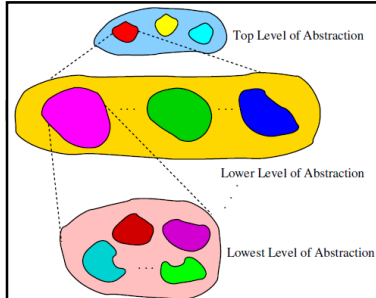


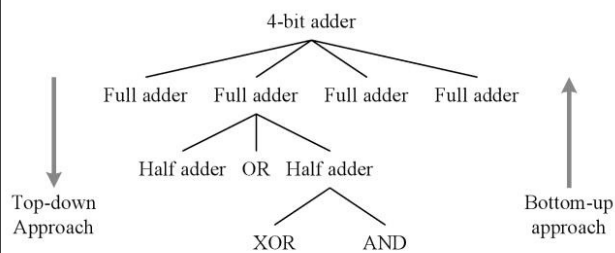
Hierarchical Design

- Divide-and-conquer: limit the number of components you deal with at any one time.
- Group several components into larger components:
 - transistors form gates;
 - gates form functional units;
 - functional units form processing elements;
 - etc.

Hierarchical Design.....

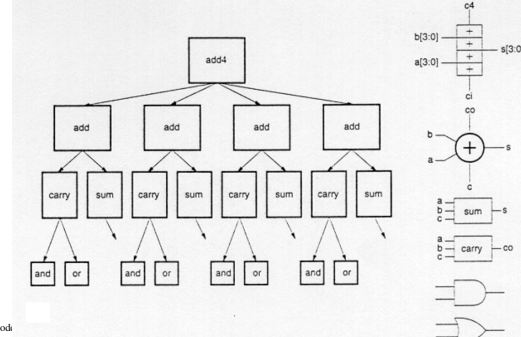


Concept of Hierarchical design



Concept of Hierarchical Design

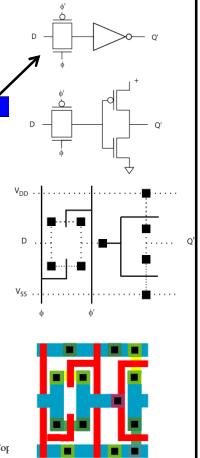
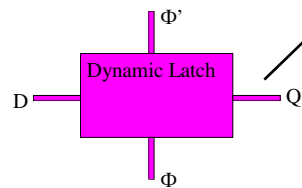
4-bit adder.....



Design abstraction....

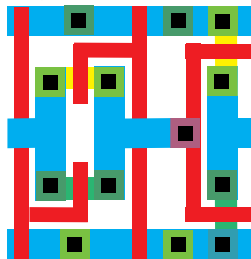
- Hardware design requires multiple-level of design abstraction to manage the design process and ensure that they meet major design goals (speed, power consumption etc.)

Example: Layout and its abstractions

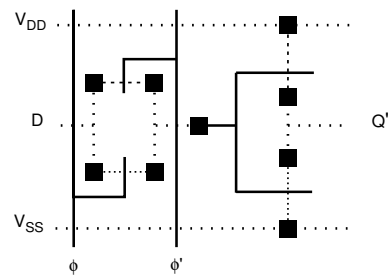


Example: Layout and its abstractions

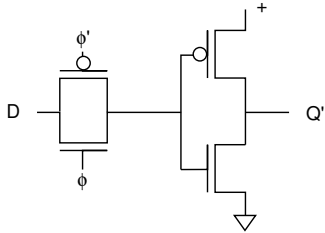
- Layout for dynamic latch:



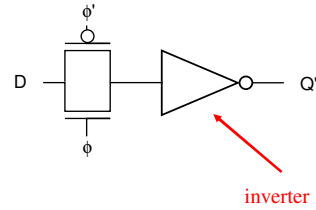
Stick diagram



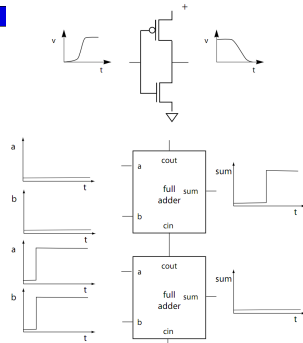
Transistor schematic



Mixed schematic



Circuit to complex logic



Design abstraction

- Complexity is reduced by successively replacing detail with simplifications at higher levels of abstraction.
- Number of components do not change as it is recast to a lower level of abstraction.
- Less common in programming.

Design abstraction and hierarchical design are not the same thing.

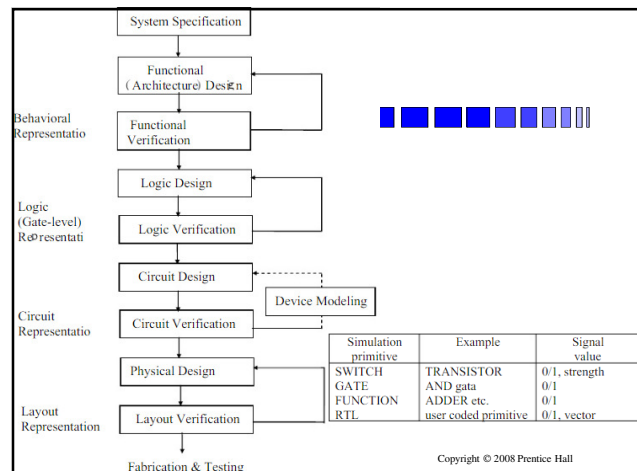
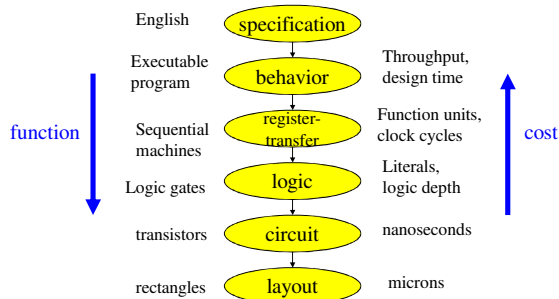
Levels of abstraction

- Specification: function, cost, etc.
- Architecture: large blocks.
- Logic: gates + registers.
- Circuits: transistor sizes for speed, power.
- Layout: determines parasitics.

Top-down vs. bottom-up design

- Top-down design adds functional detail.
 - Create lower levels of abstraction from upper levels.
- Bottom-up design creates abstractions from low-level behavior.
- Good design needs both top-down and bottom-up efforts.

Design abstractions



Design validation

- Must check at every step that errors haven't been introduced-the longer an error remains, the more expensive it becomes to remove it.
- Forward checking: compare results of less- and more-abstract stages.
- Back annotation: copy performance numbers to earlier stages.

Manufacturing test

- Not the same as design validation: just because the design is right doesn't mean that every chip coming off the line will be right.
- Must quickly check whether manufacturing defects destroy function of chip.
- Must also speed-grade.