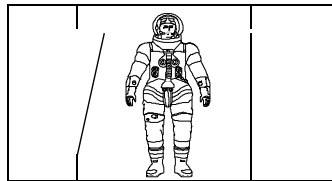
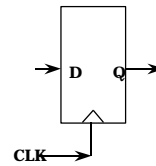


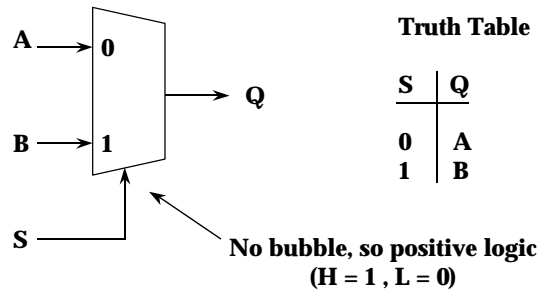
**How Computers Work
Lecture 7**

Under the Hood of Synchronous Finite State Machines

What do these have in common?



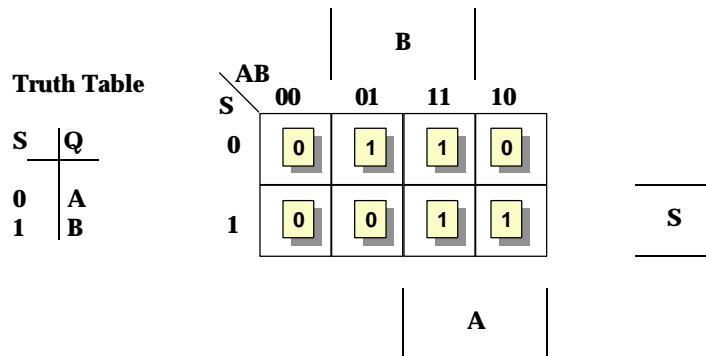
The Selector

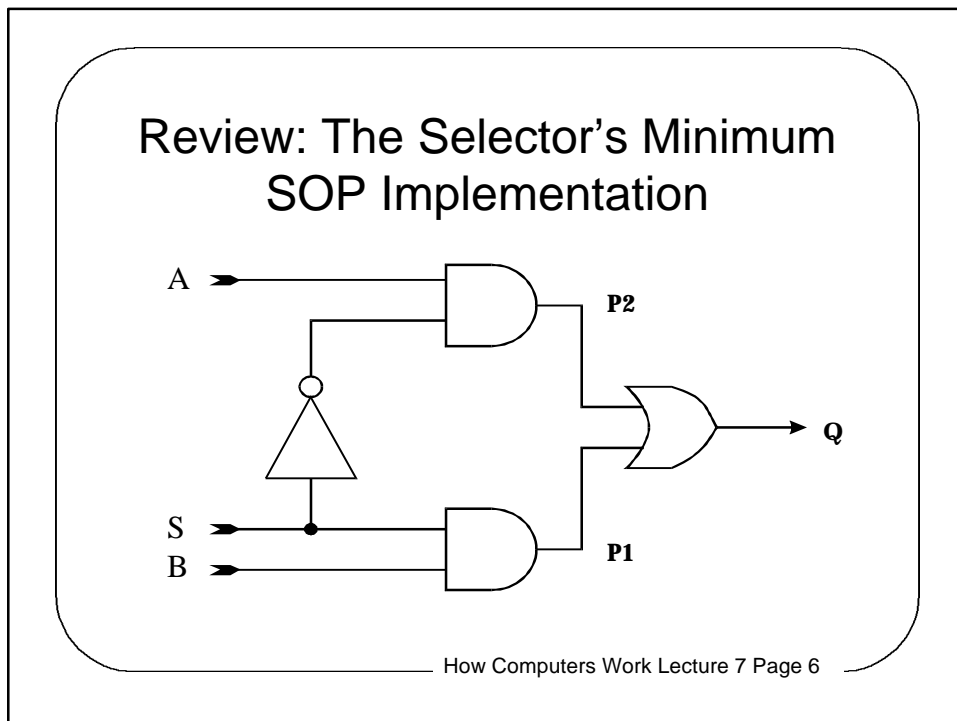
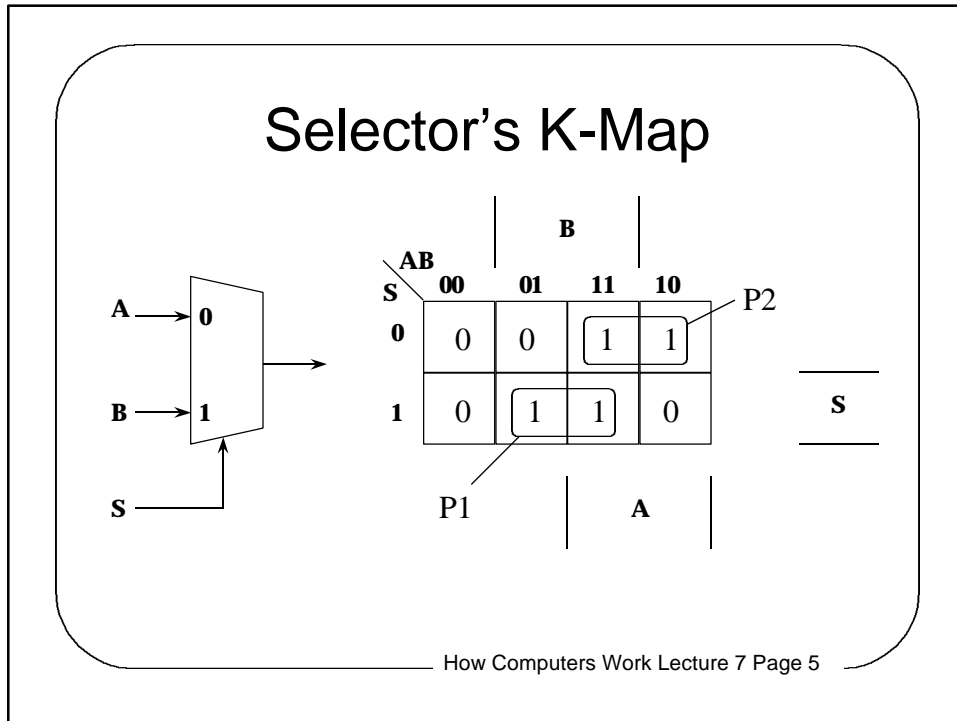


Truth Table

S	Q
0	A
1	B

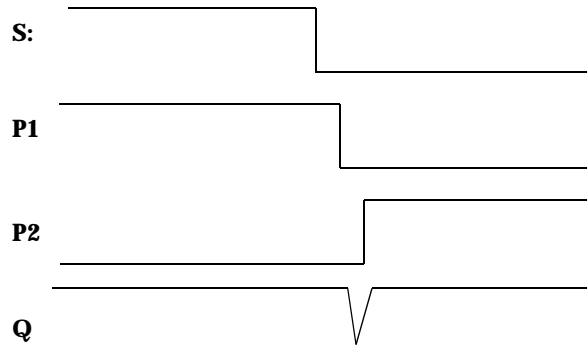
The Selector's K-Map





The Trouble with Transitions

Suppose: $A = B = 1$ (H)



How Computers Work Lecture 7 Page 7

Hazards

- **Static Hazards:**

Output Enters Forbidden Zone Unnecessarily

- 1-Hazards
- 0-Hazards



- **Dynamic Hazards:**

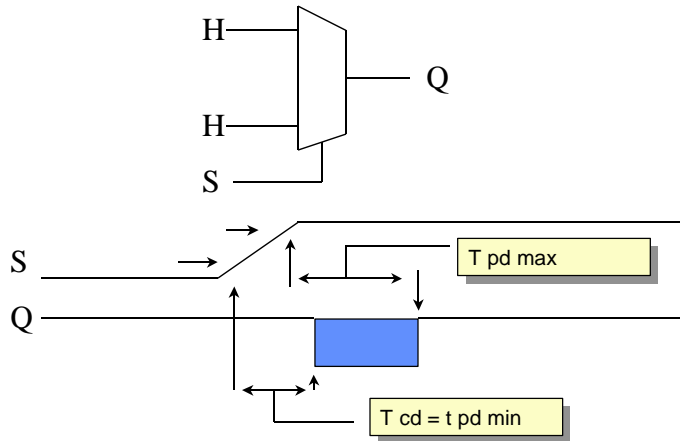
Output Enters Same Valid Zone Again after Entering Opposite Valid Zone

- 0-1 Hazards
- 1-0 Hazards



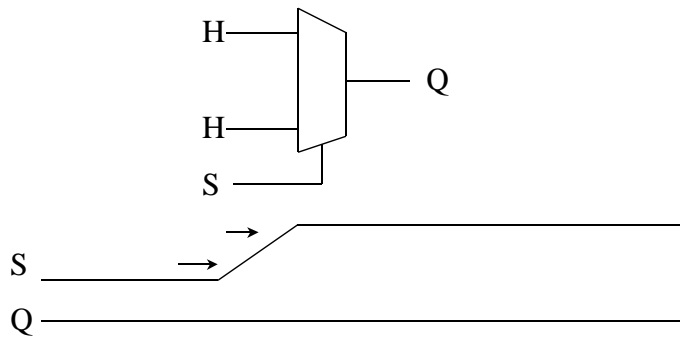
How Computers Work Lecture 7 Page 8

What You Should Expect



How Computers Work Lecture 7 Page 9

What Hazard-Free Means



How Computers Work Lecture 7 Page 10

Fundamental Mode SIC (Single Input Change) rule

- Only 1 Input Bit Can Change “At a Time”

$> T_w$

How Computers Work Lecture 7 Page 11

Fixing the Selector's 1-Hazard with a redundant product term

		B		
AB	00	01	11	10
S	0	0	1	1
1	0	1	1	0

How Computers Work Lecture 7 Page 12

Rules for Fixing Hazards in SIC SOP situations

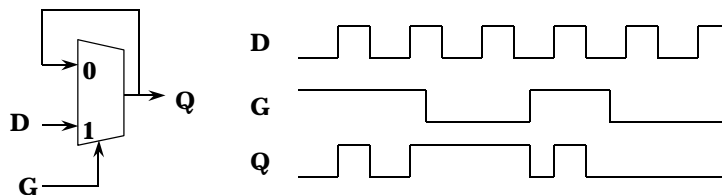
- Avoid using X and \bar{X} in a single product term
 - This insures product terms have no SIC hazards
 - prevents all dynamic hazards and static 0-hazards
- Cover all **adjacent 1** cells in K-map with at least 1 product term
 - This insures at least 1 product term remains steadily high during SIC
 - prevents static 1-hazards
- Remember - This Only Applies for SIC !!!

How Computers Work Lecture 7 Page 13

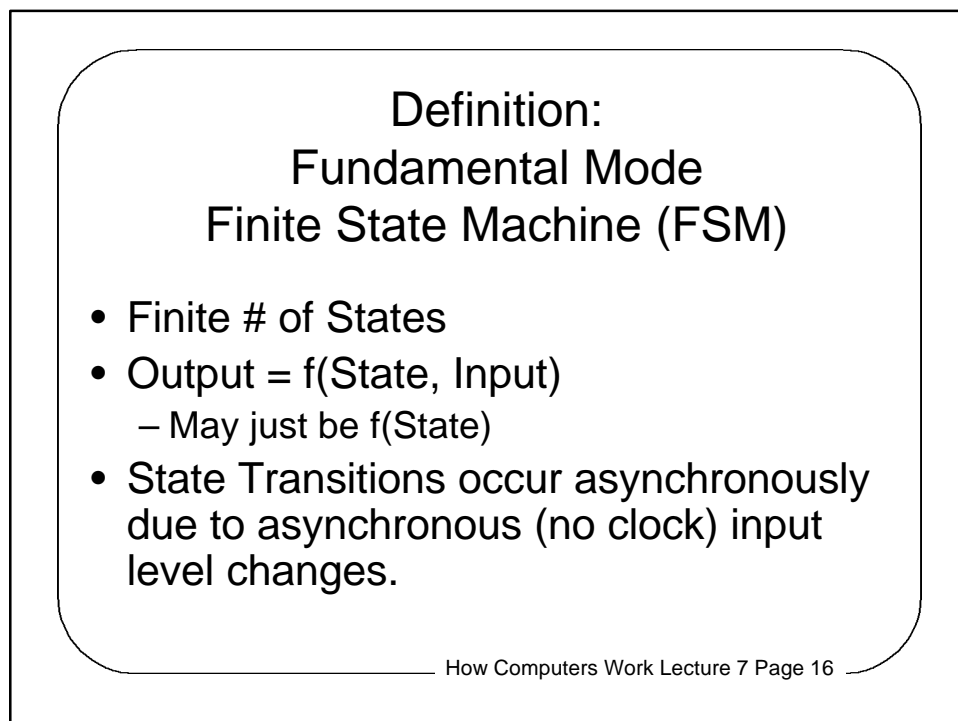
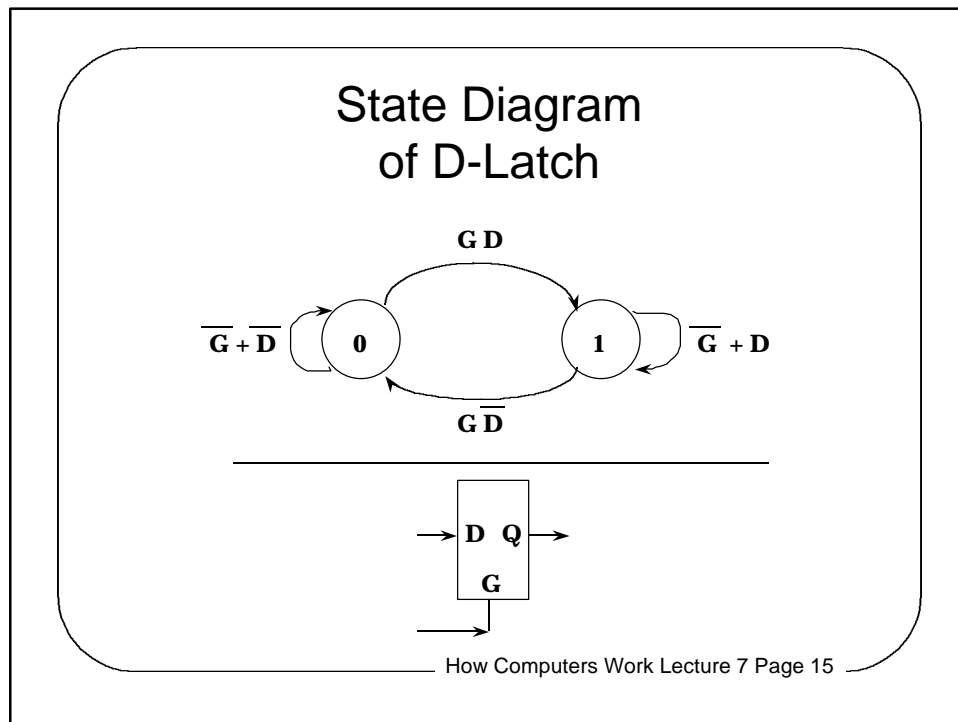
A First Taste of Asynchronous (Fundamental Mode) State Machines

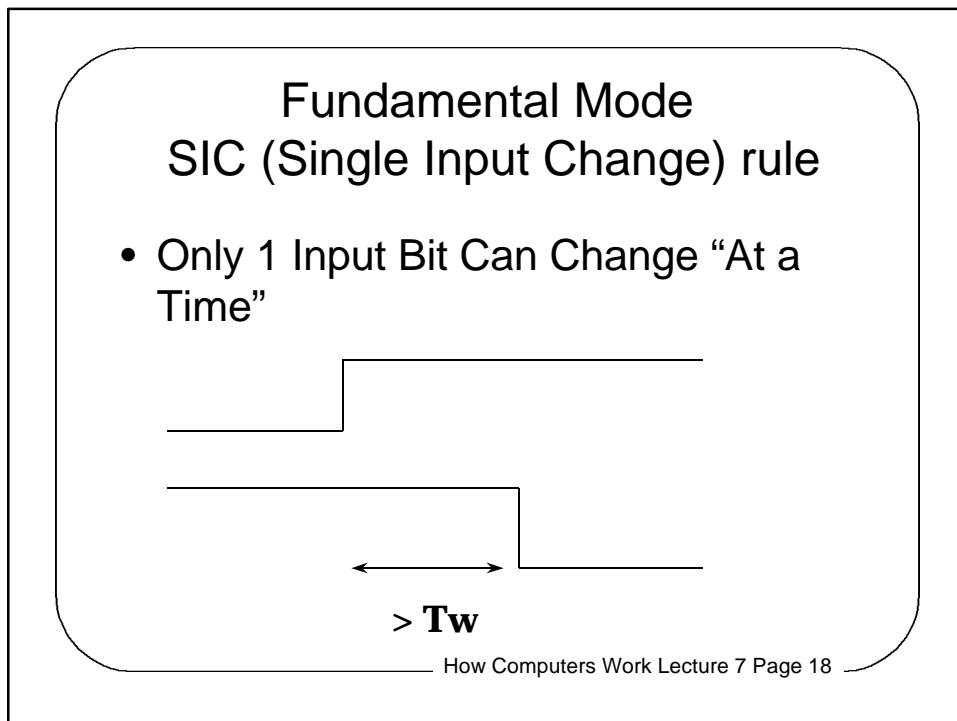
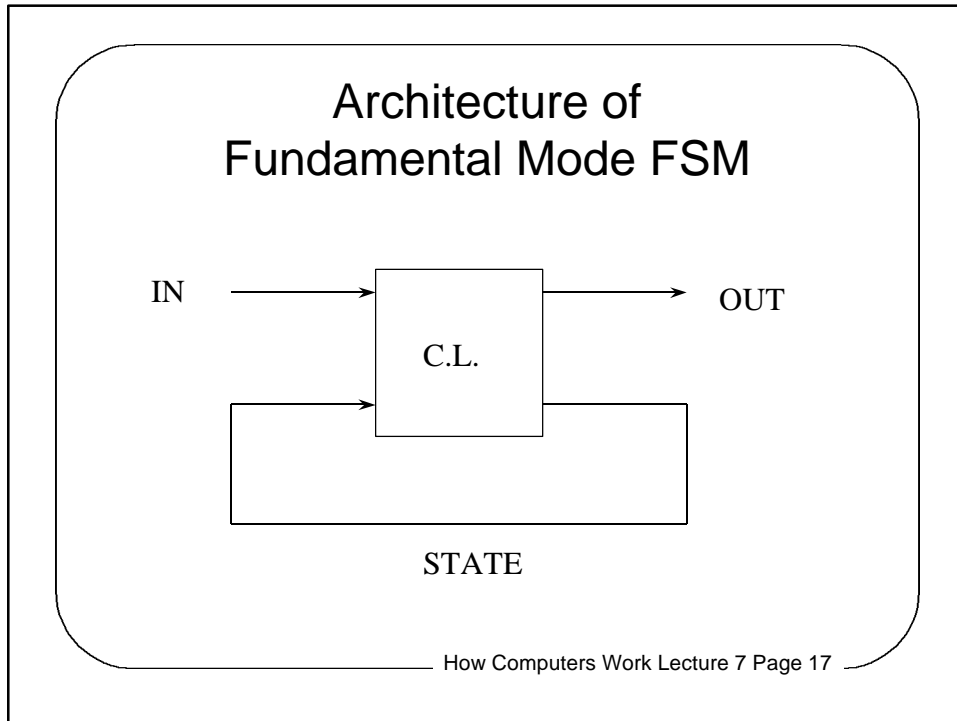


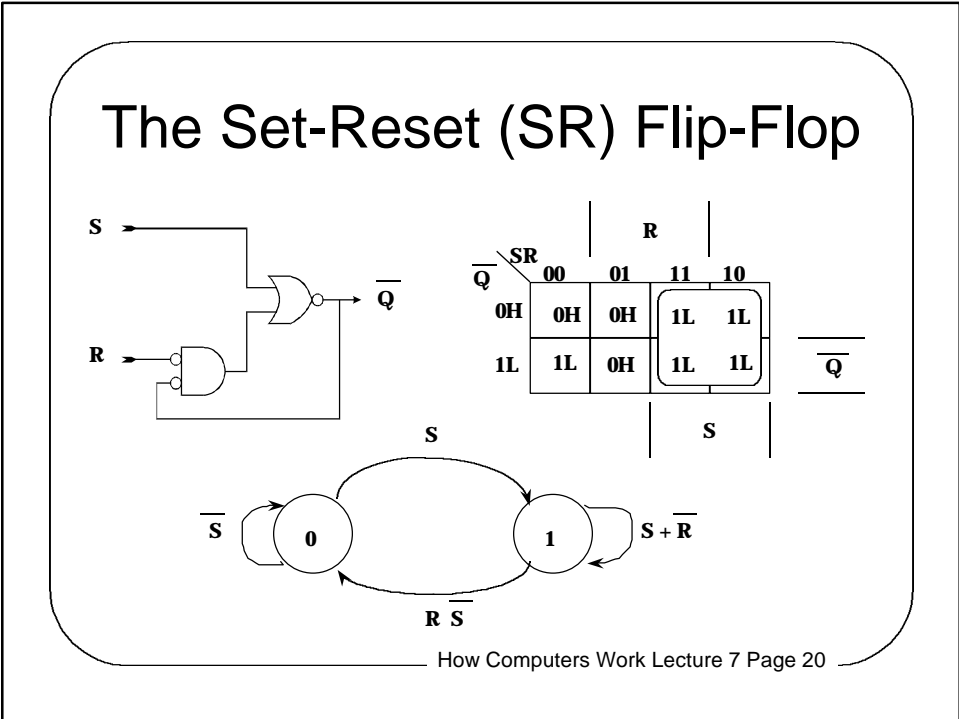
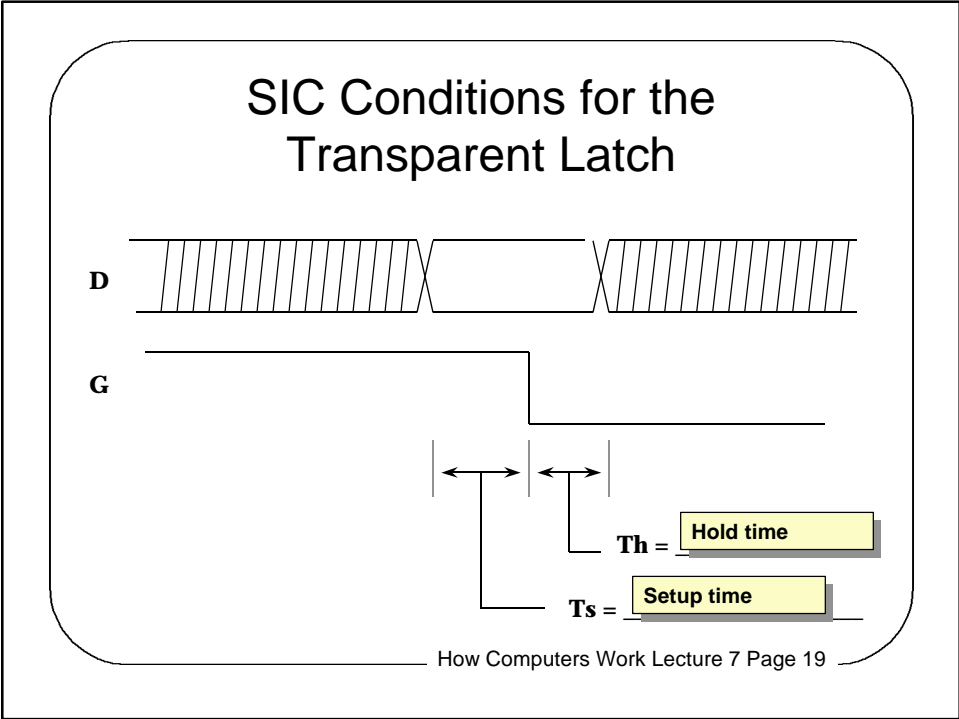
MUX Implementation of the Transparent Latch

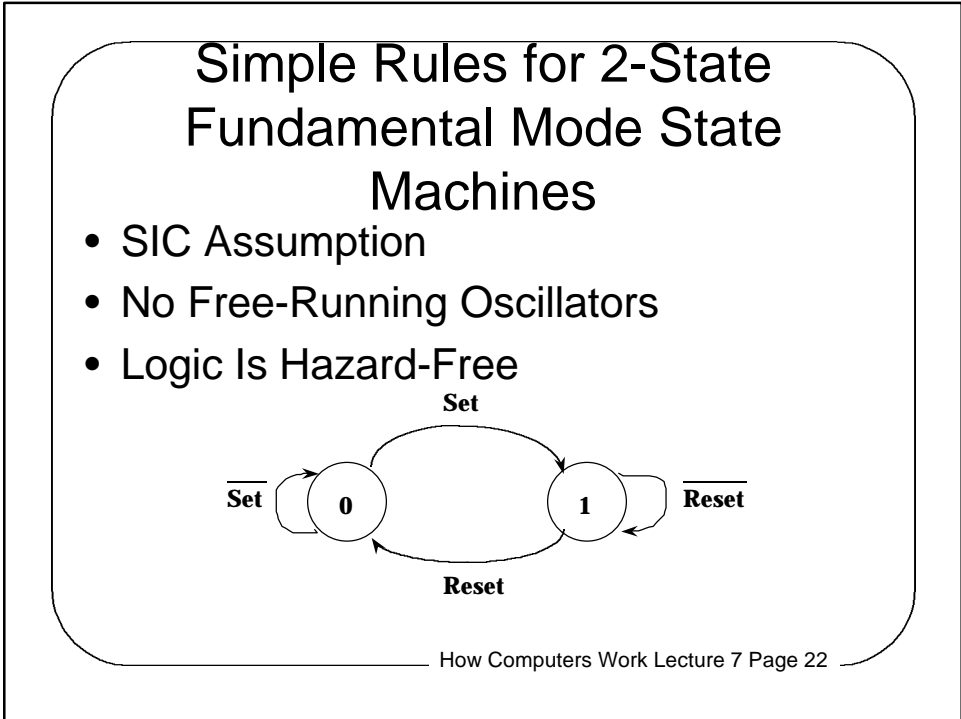
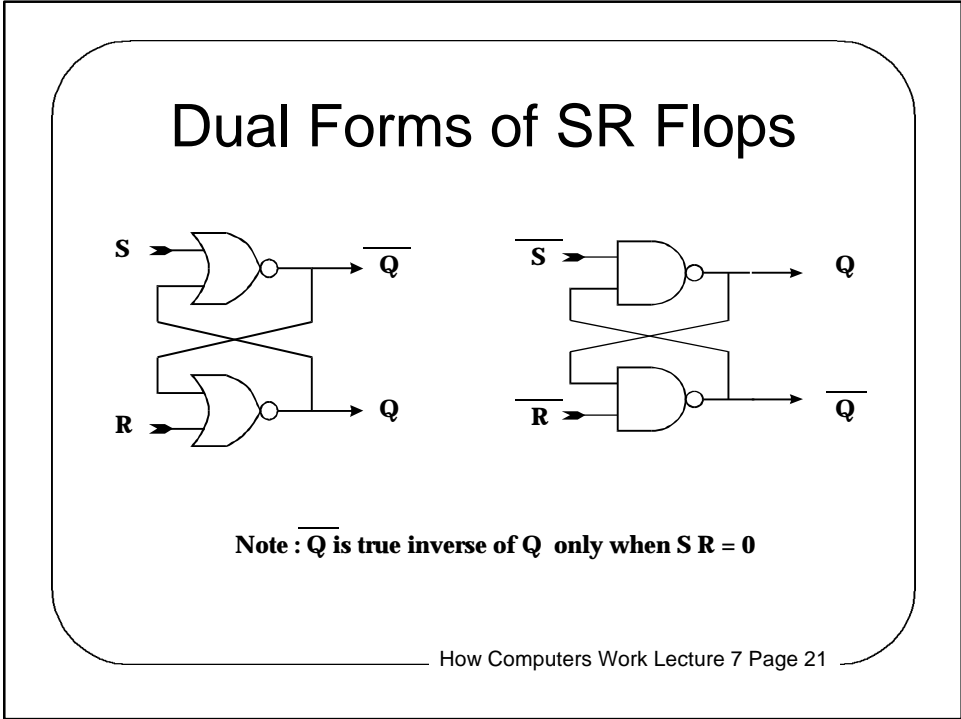


How Computers Work Lecture 7 Page 14









More Complex Fundamental Mode FSMs

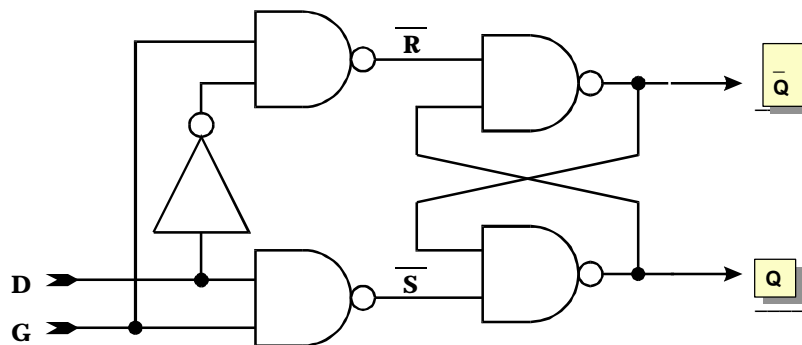
- > 2 States possible, with somewhat more complex rules
- Good behavior for non-SIC also possible, with somewhat more complex rules
- Only Certain Hazards are Important

For More Information, read:

The Essence of Logic Circuits, by Stephen H. Unger, Prentice-Hall, 1989.

How Computers Work Lecture 7 Page 23

Building a Latch from an SR Flop



How Computers Work Lecture 7 Page 24

