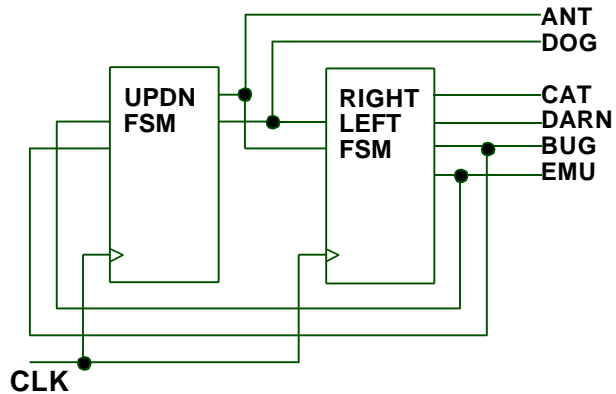


## WHY TO AVOID MEALY MACHINES ESPECIALLY ASYNCHRONOUS ONES

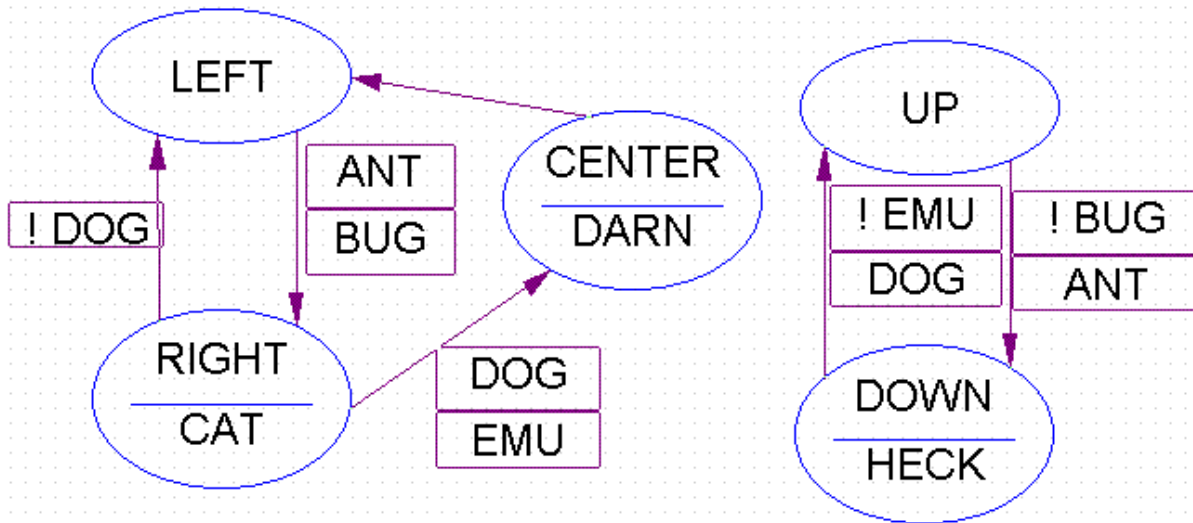
Consider the two synchronous FSM's shown in the diagram to the right. Two of the outputs from one machine are inputs to the other and vice-versa.

If either or both of the machines were Moore type machines, there would not likely be any timing problems involved in their design assuming that reasonable care was taken in the design.



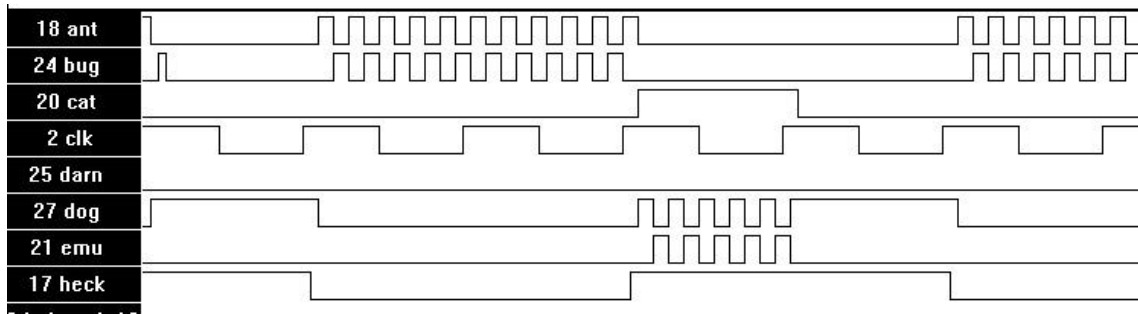
But, let us suppose that they are both Mealy FSM's with the state diagrams shown below.

MEALY.DIA  
StateCAD Diagram



The two state diagrams appear to be reasonable enough. The “left right” machine goes from “CENTER” to LEFT. When ANT is asserted, it goes to state RIGHT where it either goes back to LEFT or to CENTER depending on DOG. The UP/DOWN machine moves from UP to DOWN if BUG is not asserted and from DOWN to UP if EMU is not asserted.

Well, let's synthesize this into a 22V10 PAL and see what happens!



What is happening? For two clock periods ANT and BUG oscillate. Finally the machines switch from the LEFT and UP states to the RIGHT and DOWN states. The reason that they remained in the previous states for two clock cycles is that the oscillation just happened to be at a rate that the conditions for remaining in these states were satisfied on the first clock cycle but not the next. Using different clock frequencies would give altogether different results.

In the RIGHT and DOWN states, DOG and EMU oscillate! Then the LEFT RIGHT machine moves to the CENTER state where there is no oscillation. This sort of behavior is certainly not desirable. Can it be improved? Yes, go to Moore machines! If you insist on interconnecting Mealy machines you are only asking for trouble. Since the outputs of a Mealy machine are functions of the current inputs, if the inputs are asynchronous, so will be the outputs. Determining the timing in cases such as this is extremely difficult.

Note: This example was, obviously, purposely made to be bad for instructional purposes. It was not at all hard to make it so!