Lab #9: A Pseudo-Random Number Generator for Creating Rolling Dice
Sequential Building Blocks (Counters)
Hierarchical System Design
Revised 11/30/2011

Overview
This lab introduces another sequential building block – counters. We will look at counters in two different ways – one as a general model design and one as a finite state machine design.

Counters are commonly used in digital system design. Taking the design of a register and adding an incrementer allows the design of a counter.

One way to build a Counter (Cntr ‘A’)

Another way to design a counter is to use a standard digital system design process for finite state machines. This is the approach that will be considered in this lab. The lab period will discuss the process of designing a finite state machine.

When writing new code, it is easy to use versions from previous projects, by adding a copy of a source to a project. Make certain to add a copy and not just add a previous source to a new project – this will protect the original source from getting changed.
Before beginning this lab, you should:
• Be well practiced in the design of various flipflop circuits.
• Be familiar with the Xilinx WebPack design tool suite.

After completing this lab, you should:
• Understand the design and function of counters. - sequential building blocks.

This lab exercise requires:
• A Digilab BaSYS board
• A PC running the Xilinx ISE CAD tools

Modules created in this lab:
• Top level – random_roll
• Finite state machine that counts 1-6 – Counter_6

Modules used in this lab:
• Rising Edge Triggered DFF with Clr
  o DFF_clr
• Full-Adder-3-bit
  o Full-Adder
• Clock-Divider
• Hex7segment
Counters  (Design process for a finite state machine)

Using the process described in class, design a die that counts from 1-6. Use a btn[0] as the EN input.

In the lab exercise sheet,
   a) Write the bubble diagram or ASM chart.
   b) Write the state table (input (EN), present states, Next state, and Output columns).
   c) Determine the equations for the next states and outputs.
   d) Draw the two level AND/OR circuit for the die.
   e) Create a new project and show the counter working on the BaSYS board.

Show the values of each die as well as the sum of the two die on the BaSYS board. Use the seven-segment display to display the value of the counter.