DIGITAL LOGIC DESIGN
STUDIO ASSIGNMENT – GUMBALL EXTENSION

Standard honor statement. Your design & implementation should be your own work.

OBJECTIVE

This studio assignment allows you to design a simple controller. You will define the interfaces and coding schemes and implement the FSM, encoders and decoders to process the inputs and produce the output.

PROBLEM DESCRIPTION

You are to design a gumball machine controller using T Flip-Flops. The gumball machine accepts nickels, dimes **and quarters** (one coin at a time). A single gumball costs $0.20. The machine makes change, as appropriate, **in the appropriate amount.**

You must use the same design approach as was used in class: the "coin detector" produces 3 outputs (N,D,Q) which are inputs to your controller.

PRE-WORK

1. Define the interface between the controller and the rest of the candy machine similar to what was done in the class example (see class notes from *Monday March 13* in which we designed a similar system in class). State the requirements clearly. Design the controller in three parts: input encoder, state machine, output functions.
2. Design each separate piece and implement them in *Logisim*. Test each part separately before trying to connect the components together.
3. Design a Mealy-type FSM for the controller and implement and test it in *Logisim*. Four states are sufficient for the state machine. Use T FF for your implementation.
4. After you are confident that each of the pieces is working properly, connect them in *Logisim* to create a complete system.
5. Be sure that your design is complete and well documented. All inputs and outputs must be very clearly labeled. Use the "label" attribute rather than a text box.
6. You should notice anomalous behavior with your circuit that is a direct consequence of the fact that it's been designed as a Mealy machine. If this was a real system you would have to redesign your controller as a Moore machine. You do not need to address this problem for this assignment but you should comment on it in your demonstration.

IN STUDIO

Bring your completed *Logisim* file and your documented design procedure to the studio to be reviewed by your studio instructor. Be prepared to answer questions about your design and make suggested changes to demonstrate understanding.

NOTES

As the designer, you decide what your gumball machine will do if a user deposits forty cents. You can either give 2 gumballs or give 20 cents change. Document this decision. Your decision on this point impacts the candy release mechanism and change return mechanism (i.e. state your assumptions about what functionality is needed by these 2 components).

Define your output variables (which are the inputs to the candy release mechanism and to the change mechanism) very clearly. You will almost certainly need more than one bit to represent the "change" output.

GRADING SCALE

- 1 point for including a block diagram with clearly defined interfaces (i.e. inputs and outputs)
- 2 points for correctly designing and implementing the input encoder
- 2 points for correctly designing and implementing the output functions. You need a separate output variable for each possible output scenario.
- 2 points for correctly designing and implementing the state machine.
- 1 point for describing the anomalous behavior of your circuit to the instructor
- 2 point for professionalism, including a well-documented design process