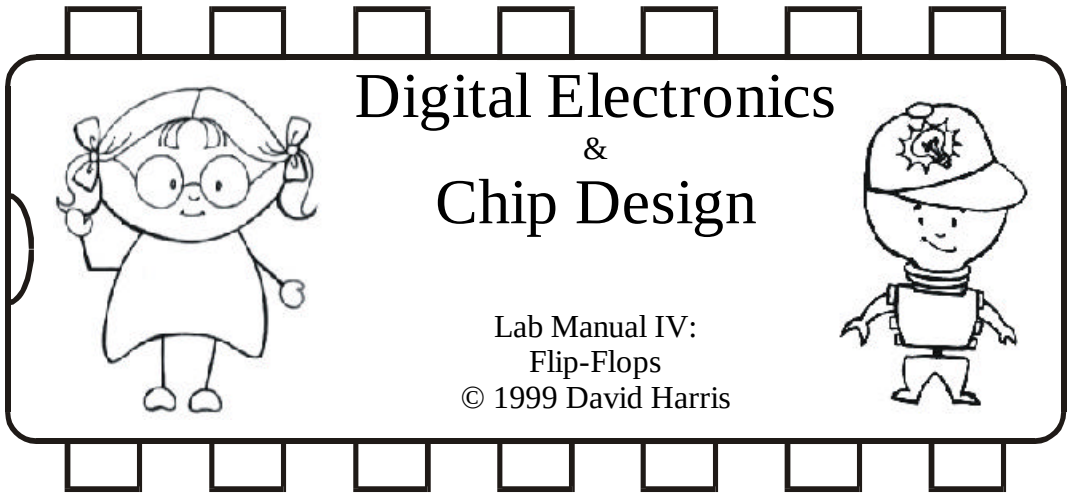

While our hero is still busy classifying Martian wildlife, we will take an aside this week to experiment with flip-flops and practice our breadboarding technique.

Part I: Constructing a Flip-Flop

The first assignment is to construct a D flip-flop on your breadboard. You may use any of the logic gates in your lab kit for this task. Before beginning, draw a schematic of your circuit and label the pins and chips used for each part. This will greatly reduce the number of mistakes you make.

Use a DIP switch on your utility board to control the D input and a push-button switch to control the clock. Connect the outputs Q and $\overline{Q}$ to your LED display.

In a circuit this size, you probably will make some mistakes. Use a wire connected to an LED display to measure the logic levels at various points in the circuit. Trace the circuit from the beginning to find where the actual voltages disagree with your expected voltages. This should indicate a mistake in your wiring.

When your flip-flop works, have it checked off.

Part II: Using the 7474 Flip-Flop

National Semiconductor describes the 7474 chip as "Dual Positive-Edge-Triggered D Flip-Flops with Preset, Clear, and Complementary Outputs." Let's translate this jargon.

Dual: two flip-flops on one chip
Positive-Edge-Triggered: captures D when clock rises from low to high
D Flip-Flops: standard flip-flop we have studied
Preset: signal to force output high independently of D and clock
Clear: signal to force output low independently of D and clock
Complementary Outputs: both Q and $\overline{Q}$

This single chip replaces two copies of the entire circuit that you have just built and, in addition, provides additional the additional functionality of preset and clear. The pinout

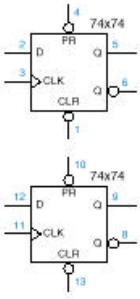

diagram is shown below:

In order to become familiar with the 7474, your next project is to put one on the breadboard and connect its controls. As always, connect power and ground. Connect the clock to a pushbutton and connect the D, Clear, and Preset inputs to DIP switches. Finally, connect Q and $\overline{Q}$ to LEDs. Experiment with the various signals.

To get this part checked off, demonstrate the following functions:

- Loading a logic 0 on a clock edge
- Presetting the output independently of the clock
- Clearing the output independently of the clock
- Loading a logic 1 on a clock edge

This lab hopefully has familiarized you with the operations of flip-flops. During the next several weeks, we are going to apply this knowledge to more interesting and complex problems.