ECE 241 Digital Systems Project 2008

Motivation, Scope, Timeline and Report
Projects

- Are great things!

- They are where you put together the pieces of knowledge that you have learned in labs & lectures

- They are what real engineers do:
  - Take fuzzy ideas, and make them into concrete reality!
When You Are Interviewed for a Job

- A common question will be: **Describe some project you worked on**

- Followed by:
  - What was the goal?
  - How did the work go? - Did it work?
  - How ambitious was it?
  - Do they speak about it with passion?
  - Do they understand the technical details of the project?
  - Do they understand the bigger picture in which the project sits?
The Project

- Done in groups of 2 – the same as group as in the labs
Choosing Your Topic

1. You must select your own unique topic
   - A chance to start coming up with your own ideas
   - Getting away from “cookbook” labs where we tell you what to do

We want each project to be different!
**Process**

2. Once you have your project idea:
   - Email your ECE 241 Instructor a **one or two line** description of the project, requesting “uniqueness” approval
     - Jonathan Rose (jayar@eecg.utoronto.ca)
     - Steve Brown (brown@eecg.utoronto.ca)
     - Belinda Wang (belinda.wang@utoronto.ca)

   □ Instructor will only allow one project for a topic

   □ He or she will respond with an email saying either:
     1. You have “uniqueness” approval, proceed
     2. Sorry, that topic has been taken, please try again.
3. Once you have a topic, you must work out the details
   – work with your ECE 241 TA; who will be assigned during lab 6
   – to determine a reasonable amount of work for the project
   – The same topic could be too simple or too much
     • depending on the details
     • e.g. a “computer” could be
       – an adder
       – or a super-computer
   – You should arrange a separate time with your TA to meet and discuss
Meeting with the TA

- When meeting with TA, YOU MUST PREPARE a single sheet of paper which contains:

1. The Names of the 2 Team Members
2. A Point form description of project
3. A Block diagram of the hardware of the project
4. A list of weekly milestones
   - to be done by the end of each ECE 241 lab period
   - there are 3 of these
The Big Question

What is a reasonable “scope” for the project?

■ A hard question,
  – Very difficult to estimate how long a project takes
  – Basic method: break into pieces, estimate each piece

■ This is difficult, even for experienced engineers,
  – often they’ll say: make a guess and multiply by 2

■ However, they do learn, to make good estimates
  – The only way to learn, is to try and fail.
  – Here, you’ll be trying and failing, but learning!
  – Your TA will help you make guesses as to what is reasonable
Some Guidelines

- Your project should have a reasonably large Finite State Machine in it.
  - At least 15 States, probably many more

- There should be a some “datapath” of significance
  - A datapath is a computation/communication of multi-bit numbers
  - The adders in labs 5 are considered datapath,
    - but simple and small ones
One of the key questions in your project is finding interesting ways to:
  - get inputs into your system and
  - to see outputs

Lab uses switches as inputs, and LEDs & 7-Seg as outputs;

Interesting projects often use other methods;
  - I’ll show some examples shortly
Popular/Available Output: VGA Display

- i.e. a computer monitor
- Use digital hardware to draw pictures on the display
- Lab 7 in ECE 241 will show you how to use this
- A good scope project is to use a VGA display & have stuff move in some intelligent way
The Display

- We provide you with a pre-designed circuit that does the most difficult parts (the “VGA Controller” below)
- To use it, you’ll need to understand how larger scale digital memories work (beyond flip-flops)
  - will soon be covered in lectures
New This Year

- Several more input/output cores for the DE2
- See: http://www.eecg.utoronto.ca/~jayar/ece241_08F/AudioVideoCores/

<table>
<thead>
<tr>
<th>List of New Cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS/2 Controller: to Keyboard and Mouse</td>
</tr>
<tr>
<td>Audio Output Core</td>
</tr>
<tr>
<td>Video-in Core</td>
</tr>
<tr>
<td>Audio and Video-In Core</td>
</tr>
<tr>
<td>Voice recorder Demo</td>
</tr>
</tbody>
</table>
Example Projects

Almost everyone’s first idea:
- Clock
- Alarm Clock
- Elevator controller
- Calculator

- After that, people start thinking harder,
  - often based on interesting input & output devices
  - you will be spending a lot of time at it – make it fun!
Example Projects

- Interesting project from four years ago: A Touchpad
  - Built a board with horizontal & vertical wires
  - Wires didn’t touch, but when pressed on they would
  - Hardware detected touch & drew box on screen where touched:
Other Projects

- Morse code sender
- Square root calculator
- Tone Frequency measuring device

- Video game –
  - Move left and right based on switches, try to collect “gold”
  - Move up and down on elevator to different levels
  - Avoid Nasties coming after you

- Video game – ping pong

- Processor – outboard DRAM display, outboard SRAM instruction memory, mouse, assembler, drawing program
Projects from Prior Years

WARNING:

The projects you are about to see were all designed in hardware, NOT SOFTWARE

- They just sort of look like software.
AND GATE Invaders

See the Video At:

http://www.eecg.toronto.edu/~jayar/ece241_08F/videos/ANDGateInvaders.wmv
Missile Command
Connect Four
Xylophone

- Electromagnetics pull down hammers on to keys
- Hardware could record and play back music
- Also displayed notes on screen
Gambling Machine
Racing Cars
Burglar Alarm
3D Cube of Doom

See the Video At:

http://www.eecg.toronto.edu/~jayar/ece241_08F/videos/CubeOfDoom.wmv
Black Jack

See the Video At:

http://www.eecg.toronto.edu/~jayar/ece241_08F/videos/BlackJackandLearning.wmv
Good Advice

See the Video At:

http://www.eecg.toronto.edu/~jayar/ece241_08F/videos/GoodAdvice.wmv
Music Maker
Mine Sweeper
Laser Draw

See the Video At:

http://www.eecg.toronto.edu/~jayar/ece241_08F/videos/LaserDraw.wmv
Shoot Sensor
Summary of Good Advice

1. Build small things that work first
   - Debug before moving on
   - “Spiral Model”

2. Simulate the small parts

3. Ask Questions
   - Friends, TA, bulletin board, instructors
   - Why? Building systems is hard, lots of little things to figure out.
What is **Really** Happening in Project

- First, we teach you the basics of digital circuits:

  - **COMPUTE**
  - **STORE**
  - Control

- Then we show you these pictures & videos:

  - Shoot Sensor
  - Composer
Then We Ask You To Think of a Project

- Your own idea, but like these ones
- THEN
- FROM your knowledge of the pieces of digital logic
- YOU put them together - build the system you thought of

In this process, you become an engineer!

An Engineer is someone who can take a fuzzy idea and make it a reality
Useful Topics to Come in Lectures

1. How the VGA Display works
   - Lab 7 next week

2. Memory
   - You likely want larger memory to store things
   - The VGA display sort of works like a memory

3. “Debouncing Switches”
   - If you want to make your own input switches, this deals with the problem that simple switches creating noisy inputs
# Time Line

<table>
<thead>
<tr>
<th>Week</th>
<th>Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 27</td>
<td>Lab 6; Think/request project topic</td>
</tr>
<tr>
<td>Nov 3</td>
<td>Lab 7; Unique Approval Due Monday Should meet with TA during this week for Discussion on “Scope”</td>
</tr>
<tr>
<td>Nov 10</td>
<td>Project Week 1; must come to lab with portion of project simulating to test 5% of grade assigned here</td>
</tr>
<tr>
<td>Nov 17</td>
<td>Project Week 2; must have second portion working; 5% of grade here</td>
</tr>
<tr>
<td>Nov 24</td>
<td>Week 3- should demonstrate full working project to TA</td>
</tr>
<tr>
<td>Wednesday December 3</td>
<td>Final Report Due at 4pm To Jason Luu, in Pratt 392</td>
</tr>
</tbody>
</table>
Final Report

- Maximum 5 pages; not including schematics and Verilog Code
- Use these Sections:
  1. Introduction
     - English description of goals of project; motivation
  2. The Design
     - Block Diagram of the major parts, and perhaps of sub-parts
     - English description of the function of each part
     - Be sure to start from top and go down. (not bottom up!)
  3. Report on Success
     - Did it work – show pictures or describe
     - For parts that didn’t work – speculate as to why
  4. What would you do differently
     - If you were going to start all over again
- Appendix: All Verilog Code and Schematics

Report Due Wednesday December 3rd at 4pm
- Hand in to Head TA, Jason Luu, in Pratt 392
Grading

- Worth 10% of your ECE 241 Grade

- Total of 40 Marks
  - 2 for First Project Week
  - 2 for Second Project week
  - 30 for overall technical content as shown in final report and in DEMO
  - 6 for quality of writing
Projects are Good! – they’re real engineering

Start thinking about your topic now

1. Get “Uniqueness” Approval by email from instructor
2. Arrange to discuss scope with TA
3. Work on project – before (prepare!) and during labs
4. Write Report
5. Become an Engineer!
Good Luck

- Projects are crucial to your engineering education!