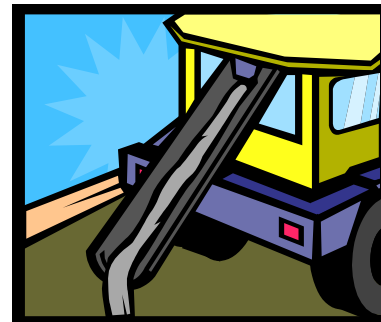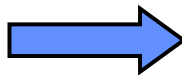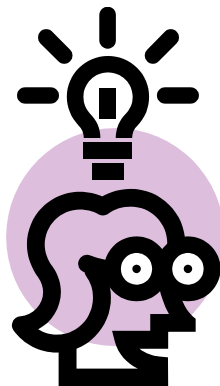# ECE 241 Digital Systems Project 2018

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?

- Employers look to see the following from the interview candidate:
  - 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 in This Course

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

- All industrial work is done in groups; as a team!

Choosing Your Topic

You must select your own <u>unique</u> 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!**

■ **One purpose of today's presentation is to help you think about topics**

Project Topic Selection Process

Only one project allowed per topic:

Check out which ideas have been taken already:

https://docs.google.com/spreadsheets/d/1PZxmbq6plC9mLd5so9_LdNYDxT17MtBzgiAUuQwVB3Y/edit?usp=sharing

It is **YOUR RESPONIBILITY** to look through this sheet and make sure that the project idea is unique.

If your idea is unique, enter it here (please be concise!):

https://goo.gl/forms/vUHhSt1fv5CGdF072

Example descriptions from past years:

- Memory game where the user has to input the pattern that was displayed on the screen.
- A two-ship battle in 6x6 space. Both ships don't know the location of the other and have one shot at a time. Game ends when one ship sinks.
- Muk-chi-ba -- Korean Variation of Rock-Paper-Scissor (Rules can be found on Wikipedia)

Deadline to submit your project idea: November 4, 11:59pm

Mentoring TA

Once you have a topic, you must work out the details
- Work with your ECE 241 TA
- Your TA will mentor you throughout 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 must arrange a separate time with your mentoring TA to meet and discuss the scope of your project**

Meeting with the TA

- When meeting with TA, **YOU MUST PREPARE a single sheet of paper that 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 third milestone being the actual demo)

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 <u>do</u> 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
- Start with something basic you know you can do
  - Add features if time permits
- We will show you projects from previous years so you get an idea of what's reasonable.

Key Part of Project: Inputs and Outputs

Inputs → **Your Digital Hardware** → Outputs

- One of the key questions in your project is finding interesting ways to:
  - get <u>inputs</u> into your system and
  - to see <u>outputs</u>

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

- Interesting projects often use other methods;
  - See examples in the slides ahead.

Popular/Available Output: VGA Display

- i.e. a computer monitor
- Use digital hardware to draw pictures on the display
- Handout on course webpage will show you HOW
- An example of a good project is to use a VGA display & have stuff move in some intelligent way in response to inputs
- You'll learn more about it in Lab #7 including how to use the VGA controller "core"

Resources

- Several more input/output cores for the DE1_SoC
- These are originally for the DE2. Not all yet tested for DE1_SoC
- See: http://www.eecg.toronto.edu/~pc/courses/241/DE1_SoC_cores/

List of New Cores
PS/2 Controller: to Keyboard and Mouse
Audio Core: **Audio input and output**
Video-in Core: **video input** (not DE1_SoC tested)
Voice recorder Demo (not DE1_SoC tested)

- Also check out https://www.altera.com/support/training/university/materials-ip-cores.html for other cores in the IP Catalogue. Use the standalone versions.
- Other tutorials:http://www-ug.eecg.utoronto.ca/msl/MSO_de1_tutorials.html

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!

Videos of Previous Projects

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

- ■ **They just sort of look like software.**

Video Demonstrations

- http://janders.eecg.toronto.edu/241_2013/
- http://www.eecg.toronto.edu/~pc/courses/ece241projects/
- http://janders.eecg.toronto.edu/ECE241_2012/
- http://www.eecg.toronto.edu/~janders/241_2011/
- http://www.eecg.toronto.edu/~janders/241_2009/

- http://www.eecg.toronto.edu/~pc/courses/ece241projects/2014/jetpackjack.mp4
- http://www.eecg.toronto.edu/~pc/courses/ece241projects/2014/ddr2.mp4
- http://www.eecg.toronto.edu/~pc/courses/ece241projects/2014/3Dmodel.mp4
- http://www.eecg.toronto.edu/~pc/courses/ece241projects/2014/AMtransmitter.mp4
- http://www.eecg.toronto.edu/~pc/courses/ece241projects/2017/harp.mp4

Summary of Good Advice

1. Build small things that work first
   - Debug before moving on
   - "Spiral Model"
   - Assume that something does not work until proven otherwise

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 <u>Really</u> Happening in Project

- First, we teach you the basics of digital circuits:
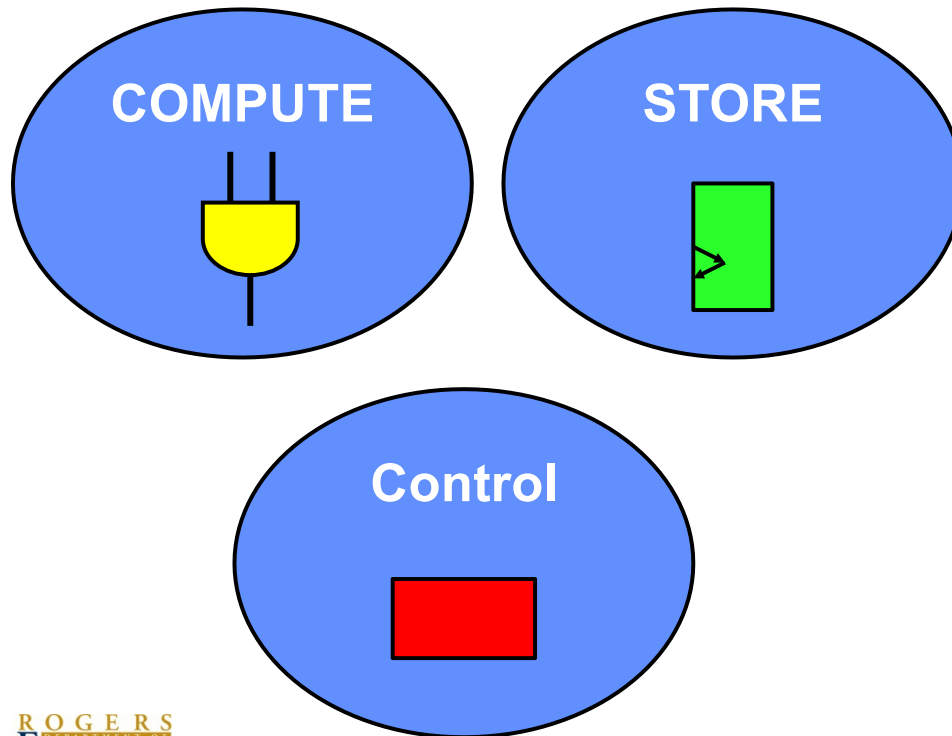
- Then we show you these pictures & videos:

COMPUTE

STORE

Control

Then We Ask You To Think of a Project

- Your own idea, but like these ones
- <u>THEN</u>
- **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!**

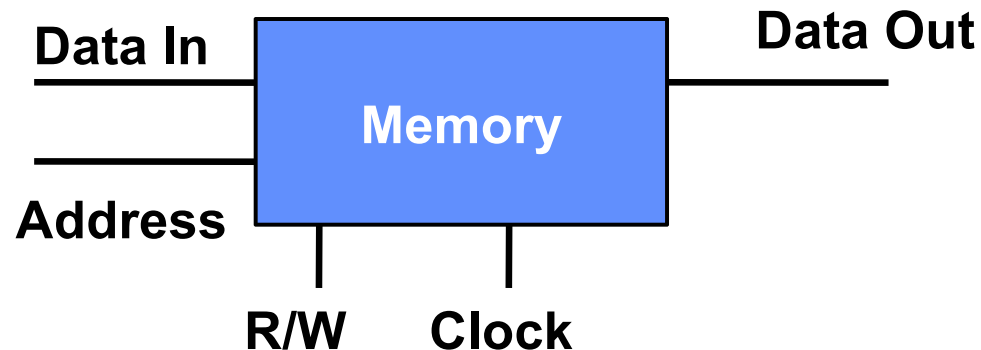**An Engineer is someone who can take a fuzzy idea and make it a reality**

Useful Topics

1. ## How the VGA Display works
   - See Lab #7

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

Data In ──────── **Memory** ──────── **Data Out**

Address ────────

R/W   **Clock**

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 for 2018

Week	Work
NOW	Think/request project topic
Nov 4, 11:59pm	Uniqueness DUE
Nov 5-9	Should meet with mentoring TA during the week for discussion on "Scope".
Nov 12	Project Week 1; must come to lab with portion of project simulating to test it. 12.5% of grade assigned here
Nov 19	Project Week 2; must have second portion working; 12.5% of grade here
Nov 26	Week 3- should demonstrate full working project to TA
Monday December 3	**Final Report Due your TA at 4pm (hand-in paper or PDF by email)**

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 Monday December 3 at 4pm
   - Send to your TA (hand-in paper, or PDF by email).

Grading

■ **Worth 10% of your ECE 241 Grade**

■ **Total of 40 Marks**
  – 5 for First Project Week
  – 5 for Second Project week
  – 25 for overall technical content as shown in final report and in DEMO
  – 5 for quality of writing

■ **Bonus marks for top projects.**

Summary

- Projects are Good! – they're real engineering

- Start thinking about your topic now

1. Get "Uniqueness" Approval
2. Arrange to discuss scope with mentoring 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!