Mini-Project Matters

ECE 362
https://engineering.purdue.edu/ee362/

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Mini-Project Intro

• Do a project that is meaningful to you, not too complicated, not too simple, that you can display, that serves as a vehicle for learning, and that you will cherish for years to come.

• The rules:
  – 2 – 4 current ECE 362 students per team.
    • You do not need to share a lab section.
  – You must use the STM32F0DISCOVERY and no other programmable computer.
  – Your project must run without additional computer support.
    • Power with 5V supply (e.g. USB phone charger).
  – Must use at least two external interface formats:
    • GPIO, PWM, analog, I²C, I²S, SPI, serial, etc.
  – Must use at least four internal peripheral subsystems:
    • Timers, DMA, GPIO, A2D, D2A, I²C, I²S, PWM
Disallowed project ideas

• Things that are:
  - Destructive (flying things, lasers, fire, high voltage)
    • Note that motors may count as “high voltage”
  - Not possible (USB, camera, audio analysis, etc.)
  - Not feasible (e.g., extensive physical construction)
  - Too simple
    • e.g., easy enough to do without a microcontroller
"I don’t know what to make."

• I spend a lot of time consulting, suggesting, and recommending.
Ideas that tend to work well

- Things that generate sound
- Graphical displays
- Simple input mechanisms
Mini-Project Bonus Points

• Design of a custom PCB: up to 4%
• Early completion: up to 1%

• Attendance at the Spark Challenge: 0.5%
  - No bonus credit for participation.
Reiterating Requirements

- You must use only the STM32F051.
  - Not another computer.
  - Not connected to another computer.
  - Not powered by another computer.
    - Phone charger
    - "Wall wart" with 5V output. (Check that it regulates at low current.)
    - Batteries with buck/boost converter.

- Use at least two interface formats:
  - e.g., GPIO, Analog, PWM, serial (RS-232, I2C, I2S, SPI)

- Use at least four internal peripherals:
  - e.g., GPIO, ADC, DAC, serial, Timers/PWM
Building your mini-projects

● Question: What kind of Op-Amp did I show?
  – LM324 Quad op-amp chip. 3V – 32V. You can use it with single-ended power supply. Not going to go rail-to-rail on the output.

● Question: Where can I solder things?
  – On bench in back of EE 069. (We need to clean it.)
    • Soldering iron, tools, solder, fume filter, etc.
Things you want to get.

- **Breadboards.**
  - Adafruit, Sparkfun, Newark: $5.95 each
  - MPJA.com: $4.95 each. Eh. OK.
  - Some places: $2.00. Do not buy these.

- **Hook-up wire.** Solid-core, 22AWG, tinned copper, multi-color, PVC insulation.
  - Adafruit: 25' of each of 10 colors: $29.95 + shipping.
  - Elexp.com: 25' of each of 6 colors: $18.95 + $15.95 shipping. Great quality, but buy something else if you're going to pay that much for shipping.
Tools

- Safety goggles.
- Wire stripper.
  - Mintcraft Multi-Function Wire Stripper. SKU #677-95323. (Von Tobel Hardware, $19. Lowe’s, $20.)
- Diagonal pliers. 4-5" long. $5–$10.
- Needle-nose pliers. Xcelite NN7776G. $25
- Flush cutter.
- DMM. Extech EX330: $60. **Continuity test.**
Buying parts

• Buy parts of electronics suppliers that specialize in selling quality parts to hobbyists.
  - You can buy solderless breadboards elsewhere for $2.00. There’s a reason electronics suppliers don’t sell them that cheaply.
Recommended Parts: Graphic Displays

- 128x64 monochrome LCD panel ($23.95):
  - www.sparkfun.com/products/710
- 240x320 color LCD touchscreen ($29.95):
  - https://www.adafruit.com/product/1770
- 7.0” 800x480 color LCD touchscreen ($47.50):
  - https://www.adafruit.com/product/2354
  - RA8875 driver board ($34.95):
- LED Matrix panels ($40 – $80). e.g.:
  - https://www.adafruit.com/product/2278
- It’s good to ask about these before you buy them.
Graphic Displays: Challenges

• The documentation is always bad.

• Interface protocols are new to you and sometimes strange.
  – “Parallel” interfaces need lots of wires.
  – “Serial” interfaces are slow.

• You’ll find hundreds of examples on the web…
  – ...for Arduinos.
Projects: You Can Use Motors

• Lots of students (and TAs) are under the impression I’m banning the use of motors for mini-projects. Not so!

• I’m simply insisting that you show me you understand the electronic characteristics of motors and inductors before you use them.

• Why?
  – It has to do with a mini-project team years ago.
Forming Teams

• Do you have a team?
  - Do you want another member to divide work?

• Are you looking for teammates?
  - Do you want to work with a team that already has an idea?

• How do you come up with ideas?
Advice: Avoid Audio Analysis

• I try to avoid talking about what teams are working on, because if I say too much students get the impression, "That’s what I should do!"

• Sometimes several teams tend to "converge" on a type of project all on their own.
  - Last semester, it was audio spectrum analysis using a strip of LEDs as a display device.
  - One team finally sent me this:
    learn.adafruit.com/raspberry-pi-spectrum-analyzer-display-on-rgb-led-strip
      • An 800 MHz, R-PI with 256MB of RAM, and floating point is barely enough.
      • How well do you think a 48 MHz STM32 with 8KB of RAM and no FP will do?
Advice: Avoid Physical Construction

- If you spend a lot of time with woodworking
  - ...that might not be the best use of your time.
What to do if you don’t know what to do

• Ask a GTA/UTA
  - They also have a lot of experience
  - Cumulatively, they also have a LOT more time than I have.
What to do if you still don’t know what to do.

- Several teams are making games. Fine.
- Some teams are making alarm clocks. Fine.
- Some teams are making musical things. Fine.
- It’s not a competition.
  - Okay to do something similar to another team.
Projects: Acquiring Parts

- Once you have an idea about what you want to do, you will have to obtain parts for your mini-project.
  - A microcontroller, alone, is not a project.
  - We’re not going to give you the parts.
  - You’re not going to get them from the instrument room.
  - They are not in your lab kit.

- What parts do you need?
- From where should you obtain them?
What Parts?

- Think about what you want to do, and what parts you need to make it happen.
- Motors?
  - It really helps to get pre-built H-bridges and other controllers.
- Are you doing audio things?
  - You will probably want op-amps, speaker, mic, etc.
  - Get advice from people who are good at this.
  - This is not an analog electronics class: Get a set of amplified "computer speakers".
- Are you using LED or LCD displays?
  - You might want driver ICs.
  - Find something you can easily interface.
  - You probably need to get a display first, THEN decide what to do.
Where to obtain basic parts?

- www.lafayettedelasticsupply.com
- Major Electronic Supply Companies:
  - Allied, Arrow, Digikey, Future, Mouser, Newark, Rochester
    - Check terms and prices for shipping.
    - Must you look at each one and compare? No: octopart.com
    - Is there any reason you can’t make an order?
      - Maybe...
Where to obtain prototyping parts?

- **Electronics Hobbyist Companies:**
  - Adafruit, Fry’s, Jameco, SeeedStudio, Sparkfun, etc.
  - They sell "breakout boards" and things that are easy for you to use *first* having to design a PCB.
  - Do **not** select a pre-designed project that you only have to assemble.
  - Do **not** select a system described as an Arduino Shield, BeagleBone Cape, or a Raspberry Pi Hat.
Where to obtain parts?

- How about free parts?
    - Analog Devices will give you two of anything they make for free.
      - Not development or breakout boards, though.

College Parts Program

Analog Devices' College Relations program has made it a priority through its Parts Program to enhance the hands-on experience of students and acquaint them with our products before they become either our employees or our customers.

Order Parts Here
Where to obtain more parts?

• Electronics Surplus Outlets
  – They buy commodity electronics parts inventories from companies in liquidation or that are terminating large projects.
  – You have to know what you’re looking for.
  – Prices are often excellent.
  – Unfortunately, we don’t have any nearby.
    • midwestsurplus.net (Dayton, OH area)
    • meci.com [AKA Mendelson’s] (Dayton, OH)
Where to obtain more parts?

- Online Electronics Surplus Retailers
  - allelectronics.com
  - alltronics.com
  - bgmicro.com
  - eio.com (Robotic Arm)
  - electronicsurplus.com
  - jdr.com
  - mpja.com
  - sphere.bc.ca (Nixie Tubes)
  - unicornelectronics.com
Where to get misc things

- Cases, enclosures
  - Lafayette Electronic Supply
  - Fry’s (Fishers)
  - Goodwill, Salvation Army store, Lafayette Surplus & Salvage
    - Suppose you’re building a telephone-like thing.
    - Go to salvage store, buy an old phone, remove old electronics, add microcontroller.
    - Professional-looking result for a low price.
Printed Circuit Boards

• You get bonus credit if you make a printed circuit board for your mini-project.

• "How much will this cost me?"
  - 4pcb.com: 2-layer, 60in², $33 each.
  - 4pcb.com: 4-layer, 30in², $66 each.
  - SeeedStudio.com: 2-layer, 100cm², 10 boards, $5.
Mini-Project Registration

• Send e-mail to: ece362@ecn.purdue.edu
• Subject: mini-project registration
• ECN logins for you and your teammates
• What kinds of internal peripherals are you using? (four or more)
  – Anything with a box inside the diagram of the STM32.
• What kinds of external interface formats are you using? (two or more)
  – Options: GPIO, analog, PWM, SPI, I2C, asynchronous serial
• Briefly: What are you making, and what are you making it out of?
• Briefly: How will you demonstrate it?
• Briefly: How do we define a successful project?
  – If your demonstration does not meet these criteria, your score will be negatively affected.
Registration Reply

- Acceptance or Suggestions for revision
  - Complexity of your project will determine your maximum score.

- Your team number
Registration Example #1

From: bob43@ecn.purdue.edu
To: ece362@ecn.purdue.edu
Subject: mini-project registration

Logins: bob43, jim865, steve125, dave078
Peripherals: ADC, DAC, SPI, GPIO
External interface types: Analog, GPIO, SPI
What we’re making: an audio-in, audio-out machine that stores audio on an SPI memory device, and displays selections on the CFAL1602.
How will we demo: It will play a song, and you can sing along with it and record your voice with it.
Criteria for success: Play, record, mix, play back audio.
You are team 023.
Status: Conditional approval.

Your project will earn a 100% if you can demonstrate everything you plan to.

I am curious what this "SPI memory device" is. Please explain.
I am curious what this "SPI memory device" is. Please explain.

We plan to use a few Microchip SST25VF016B SPI flash storage chips. They’re surface mount packages, but we know how to solder them to breakout boards as well as design a PCB.
From: ece362@ecn.purdue.edu
To: bob43@ecn.purdue.edu
CC: jim865@purdue.edu, steve125@purdue.edu, dave078@purdue.edu
Subject: Re: mini-project

I am curious what this "SPI memory device" is. Please explain.

We plan to use a few Microchip SST25VF016B SPI flash storage chips. They’re surface mount packages, but we know how to solder them to breakout boards as well as design a PCB.

Sounds great. I approve. Carry on.
From: marylou5@gmail.com
To: rick@purdue.edu
Subject: mini-proj proposal

---------------------------------------------------------------------

Logins: marylou5@gmail.com, ed@hotmail.com, stu6@fastmail.net
Peripherals: Port A, Port B
External interface types: Timer 1, DMA

Please see the attached Word document that describes our project in great detail.
No reply

• Reasons for no reply:
  – Sent to the wrong e-mail address.
  – Did not say "mini-project" in the Subject line.

• Other problems:
  – Didn’t list the ECN logins of teammates.
  – Timers and DMA are not external interface types.
  – It’s not plain text. (I will not accept attachments.)
Registration Example #3

From: phil923@purdue.edu
To: ece362@ecn.purdue.edu
Subject: mini-project registration

----------------------------------------------------------------------
Logins: phil923, peter219, osmosis1, filbert
Peripherals: GPIO, Timer, SPI, ADC
External interface types: Analog, GPIO, SPI
What we’re making: A device where you type in an RGB value, it displays that value on the CFAL1602, and lights up an RGB LED. A variable resistor will be read using the ADC to control a pulse rate for the LED.
How will we demo: We will type in numbers and watch the LED.
Criteria for success: Working keypad, LED, LCD display. KTHX BYE.
You are team 058.

Status: Rejected.
Your project is simply a combination of labs 5 & 6. Think of something more interesting or useful.
From: tesla@purdue.edu
To: ece362@ecn.purdue.edu
Subject: mini-project registration

Logins: tesla, edison, volta, faraday
Peripherals: GPIO, Timer, PWM, ADC
External interface types: Analog, GPIO, PWM
What we’re making: A Tesla Coil modulated with PWM that will play music read through the ADC.
How will we demo: We will hook up an MP3 player to the ADC and be serenaded by lightning.
Criteria for success: You will hear the music clearly.
From: ece362@ecn.purdue.edu
To: tesla@purdue.edu
CC: edison@purdue.edu, volta@purdue.edu, faraday@purdue.edu
Subject: Re: mini-project registration

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NOPE!

(Save it for senior design.)
From: otolith@purdue.edu
To: ece362@ecn.purdue.edu
Subject: mini-project registration

Logins: otolith, cranial, eardrum
Peripherals: Port A, Port B, Timers, PWM
External interface types: Analog, GPIO, PWM
What we’re making: We’re making an alarm clock with a keypad to set the alarm time or clock time.
How will we demo: We’ll set the alarm time and wait for it to happen.
Criteria for success: The alarm will play.
You are team 002.

Status: Conditional rejection.
Are you really using external interface type of "analog"?  If so, how?

How will you demonstrate a clock that must run accurately for days in a 5-minute demonstration?