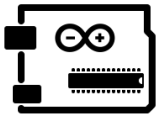
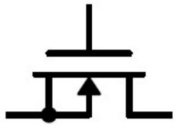
NORTHERN ARIZONA UNIVERSITY
College of Engineering, Forestry, and Natural Sciences



Micron Technology, Inc.

Large Scale DRAM Array Model



"DRAM ENGINEERS"
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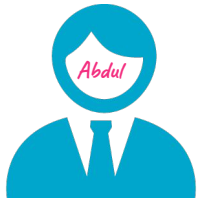
Capstone Mentor: Ashwija Korenda, Teaching Assistant
Faculty Mentor: Julie Heynssens, NAU Lecturer

Our Client

Daniel Eichenberger

Test engineer from Micron Technology, INC.

- Requested an eight by eight DRAM array model.
- Plans to use the DRAM model as a demonstration of DRAM functions to prospective memory and Micron engineers.



Introduction

Goals:

- **General Purpose**
  Build a DRAM array with external controller (Arduino Mega) and a robust board.
- **DRAM array**
  Contains 8 by 8 DRAM cells connected with 8 word-lines and 8 digit-lines, which could be controlled manually using push buttons to select a cell and toggle switch to select what to write.

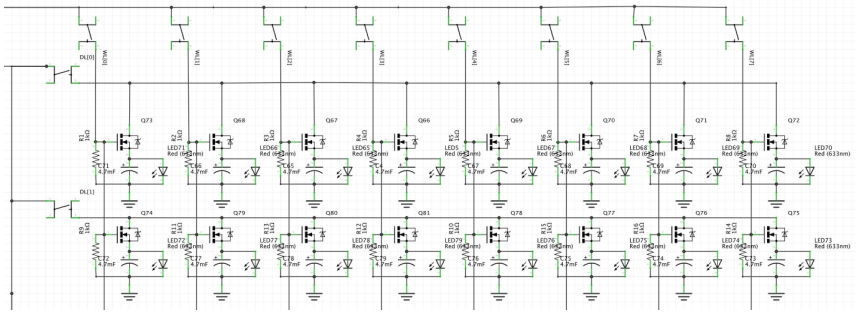
Goals:

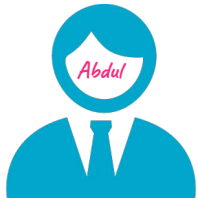
- **Arduino Mega**
  Allows user to send the certain address of digitlines and wordlines and charges the DRAM array automatically.
- **Carrying Board**
  Be large enough to hold the DRAM array, Arduino and battery.

Project Overview

Our project consists of 3 main subsystems

01. DRAM Array
    a. The user will be able to write to, read from, and refresh the array using exte nal inputs.
    b. The array is comprised of sixty-four cells.
    c. An LED on each cell will shows the user if a “1” or “0” by brightening or dimming.

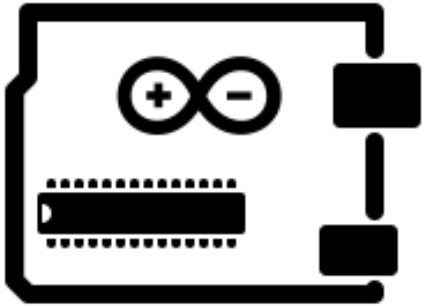


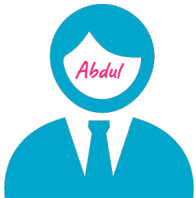


Project Overview

Our project consists of 3 main subsystems

02. Microcontroller
    a. The microcontroller will access specific m-bit cells for the user.
    b. Users use the serial monitor to enter digit and wordline addresses.
    c. LEDs on the array will show which cell was written to for a short period of time.

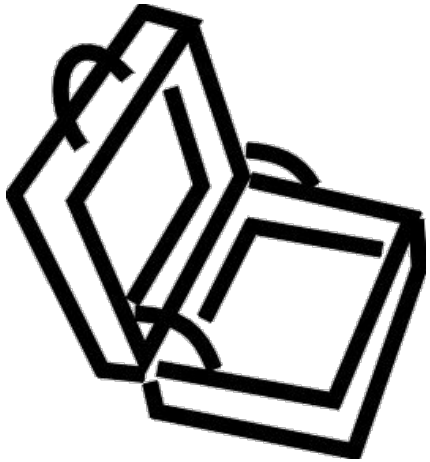


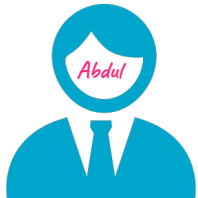


Project Overview

Our project consists of 3 main subsystems

03. Carrying Board
    a. The model will be completely safe and portable on a carrying board.
    b. Overall, the model measures 20" x 7"x 6"(L x W x H).





Project Process

- Fall 2017: Theory Analysis and Design Assumptions
- Early Spring 2018: Circuit Design and Manual Tests
- Later Spring 2018: Software Implementation and Final Tests

  - There were other design ideas we made in the first semester.
  - After several tests, the results showed the best design solution that satisfied all of our DRAM requirements.

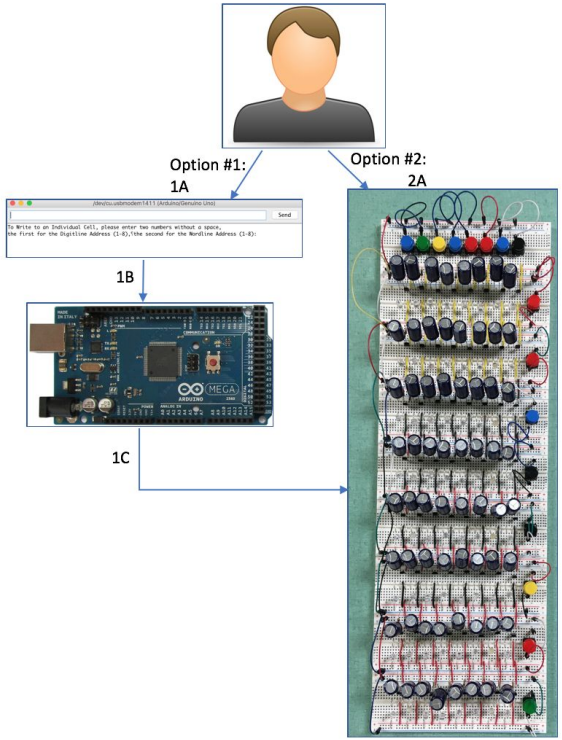
The DRAM Model process

Option 1

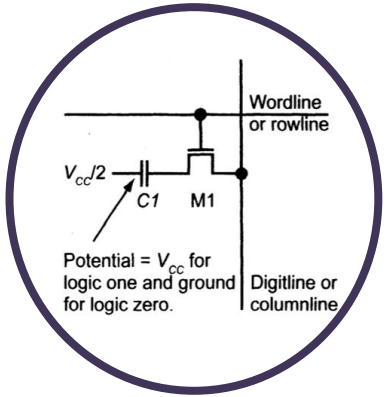
A. User is prompted by software to enter WL (wordline) and DL (digitline).
B. The microcontroller writes to the user's selected array address.
C. Displays on the DRAM 64 mbit cell array

Option 2

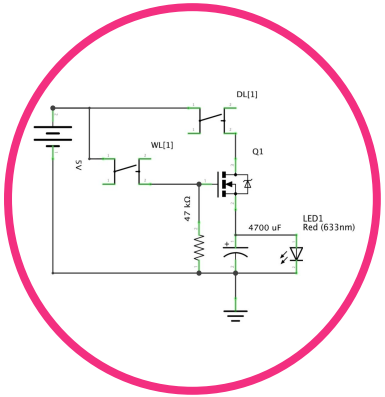
A. Manually write to the array by interacting with the push buttons on wordlines and digitlines and toggle switch for writing a "1" or "0".



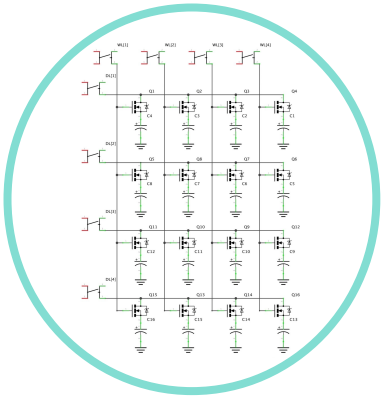
The details are in the Cell



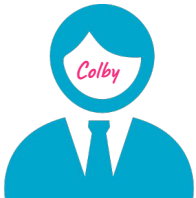
Theoretical m-bit schematic



M-bit schematic used in model



Grid-connected configuration



Project Challenges

Design of the DRAM Array

Construction in an 8x8 grid-connected configuration:

- Floating gates on the transistors led to multiple cells being able to be accessed at once.
- Resistors tied to ground at the gates eliminated this problem.

Programming the Microcontroller

Interfacing with the Array:

- Arduino voltage not large enough to light every cell.
- 9V battery implemented to power the entire array.
- Arduino now used exclusively for optional software access to the array.

LIVE DEMONSTRATION

Conclusion

- Daniel Eichenberger requested a functional 8 by 8 DRAM array to emulate DRAM functions.
- Our project consists of the three main subsystems:
  - Array, Microcontroller, and Carrying board.
- We have met all of the needs and requirements from our client and is satisfied with the model.
- Our client plans to demonstrate this model for future career fairs and prospective memory engineers.

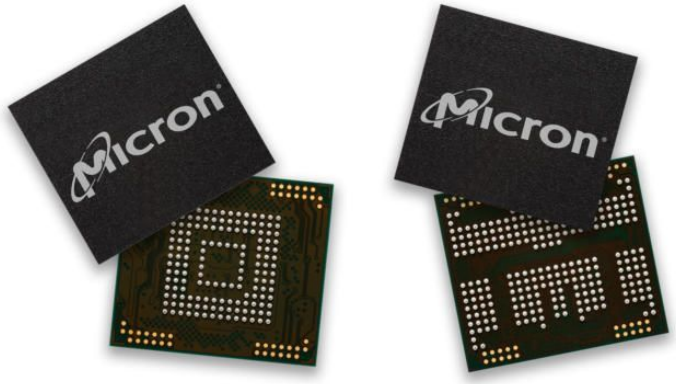
For more information, refer to the following:

- "DRAM ENGINEERS" Team Website

  https://www.cefns.nau.edu/capstone/projects/EE/2018/DRAMBoard

- Micron Technology Website

  https://www.micron.com



Thank you!

Questions?