# EECE401 Senior Design I

# Electrical and Computer Engineering
# Howard University

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# "Senior Design" – brief definition

- Is
  - Culmination of EE/CpE Education, Training, etc
  - **Design** *experience* that requires adequate consideration of
    - **Knowledge**
    - **standards,**
    - **Constraints, and**
    - Should be related to the **electrical/computer engineering discipline**.
  - *Process* to final product (through Senior Design II)
  - Usually team-based problem solving, inventing, etc.
- Is NOT
  - Further expansion of a class project
  - Final product only

# "Design" – Full Definitions

- ABET
  - "The **process** of devising a system, component, or process to meet desired needs," which involves
  - "A **decision-making** process (often iterative), to convert resources optimally to meet the stated needs" by applying basic sciences, mathematics and engineering, adequately considering
  - knowledge, standards, and constraints related to the electrical/computer engineering discipline."
- Industry
  - (1)"Determine that a need exists with a customer for specific goods or services and how much that customer is able and willing to pay for it.
  - (2)Then determine if the product or service is compatible with the competencies of the company and if it can be manufactured at a cost that is less than the customer will pay.
  - (3)If so, proceed by designing to match the company's ability to manufacture, rather than basing the design on state-of-the-art technologies.
  - (4)Finally, prior to full implementation, prepare a pilot demonstration"

# Engineering Design-Overview

- **Problem Formulation**
  - Recognition of a set of **needs**
  - **Information** gathering about the needs
  - Determine the **requirements** of the project
- **Problem Solving**
  - Investigates the available **alternatives** to meet the requirements – **Current State of the Art**
  - **Generates and Analyzes and Specifies** alternatives with the requirements
  - **Makes Decision** on which alternatives will be implemented
  - **Selects** the Top Design
- **Solution Implementation**
  - Creates an <u>implementation and test</u> **plan**
  - Follows the plan to **build** the design
  - **Evaluates** against the requirements from problem formulation

# Characteristics of Design

- Design is:
    - Process cycles through the 3 phases of Problem Formulation, Problem Solving, and Solution Implementation
    - systematic, not trial-and-error
    - adaptive, not a recipe (nor a cookbook)
    - process, not an event or product
    - Iterative back to earlier phases
    - Simultaneous in refinements of the needs/requirements
    - Done based on Engineering and Scientific Knowledge
    - To be Rigorous in testing and evaluation
    - To execute planned activities
    - To comply regulation, codes, rules, standards, etc
    - "Very demanding, overwhelming but awakening experiences that I utilized in my job interview and apply in my work now" – former student

# A Case for Bus Boy Robot

_Versal._ 8/10

_Robo Drop Table?_ ?
?
?

_you just copied - No chope?_

| Today's Date | |
|---|---|
| Design Requirement Execise | |
| Team Name: | |
| Project Title: | |
| Problem Statement (1 | |
| Member 1 | |
| Member 2 | |
| Member 3 | |
| Member 4 | |
| Member 5 | |

| Design Requirement Item | Specification | Reason (NEED) |
|---|---|---|
| Interface | Wireless/Wired connectivity | Connection between the robot and kitchen |
| Weight | Less than 10 lb | Lighter robot is efficient in loading |
| Noise Level | Less than 20dB at 1 ft from the device | The noise shoud lot irritate party attendees |
| Speed Performance | The max speed is 5 mph and the min speed is 2mph | Should not hit persons |
| Loading | Max loading is 30lb | Too many used dishes would cause hazard for party attendees. |
| Standards | EMC standards, FCC part 15 standard | The product must be marketable, and should not interfere with the audio/video systems of the party place |
| Cost | Prototype cost <$300 (excluding the Atom board) | The product must be cheap or resonably priced. |
| Battery Life | 1 full charge shoud allow 5 hours of use | The product should work continuously over the party period |
| Safety | Sensors | The product should avoid a collision with objects. |
| Maintenance | Liquid will pour into bottom basin | Product should avoid spills |
| Dimensions | 24"x36"x30" | Product should not be in the way of party attendees |
| Environment | The system should run up to 5 hours and automatically shut off if temperatures exceed 90F | To assist with overheating |
| Patents | Must not infringe on the following patents: D413551, 5519814, and 5303384 | |

_Safety standard?_

# Bus Boy - Design Requirements

- It must weigh approximately 40lbs so that the weight of the motor, battery and load (15lbs of dishes) are accounted for.
- Must have dimensions of 24" x 36" x 30" (?)
- Should be able to travel comfortably between 2 and 5 miles/hour
- Should function with a noise level less than 20db at 1ft from the device
- No interference with phone/audio/visual signals in the vicinity
- Must be a container integrated in the design that allows all liquid to drain into a basin without causing any damage to the wiring
- Must be able to return to the base for unloading, back to service again.

# Bus Boy - Current Status of Art

Hammacher Schelemmer Room Tidying
PickUp Robot

- Picks up objects on command & loads onto cargo bed
- six rubber wheels at 2lbs each dimensions 13" L x 8 1/2" W x 8" H
- Is equipped with a remote to drive Picks up items around 1oz. such as balls, toys or socks .
- Can operate autonomously using its four infrared "eyes".
- Seek and discovers objects within an 8-12" range.  Once object is secure it will be deposited into its cargo bay. The robot will vibrate in order to dislodge the objects from its bay.

Willow Garage PR2 Robot



- 11 teams of roboticists at 11 different institutions to take in a beta robotics project in June 2010

Teams received:

- two-year loan of a Personal Robot 2. This Personal Robot 2 (PR2) which is a completely programmable machine
- free, open-source Robot Operating System (ROS) framework with software libraries for perception, navigation and manipulation.
- One team is looking at getting the robot to learn how to carry an object through a crowded space.

# Solution Approach

✓ Ordered Rex-14D bot



Section A: Top surface of Drop Table. Will include an enclosed railing for containment of dishes along with slits leading to a container for draining.
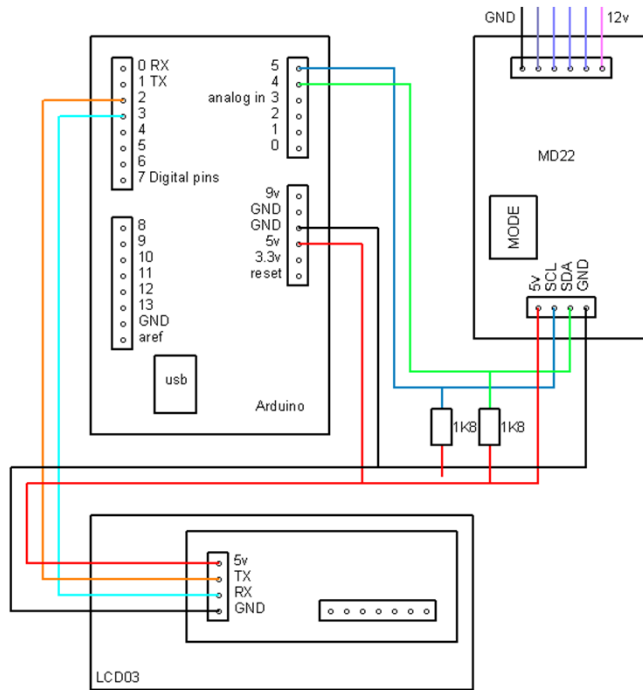
**A**
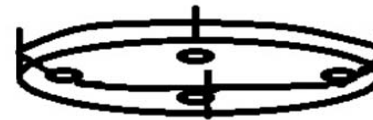
Section C: Will be the base of the Drop Table, containing 'the engine' of this robot. This includes Atom Board, motors, and batteries, and everything else to power the bot (including some sensors where necessary).

**B**
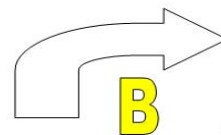
Section B: This is a critical section due to it holds liquids that were drained from the top and want to keep Section C dry. If any other storage is needed this is also the space designated for it (while not interfering with the liquid waste).

**C**

# Solution Approach



GND | 12v

0 RX
1 TX
2
analog in 3
3
2
4
1
5
0
6
7 Digital pins

MD22

8
9
10
11
12
13
GND
aref

9v
GND
GND
5v
3.3v
reset

MODE

usb

Arduino

5v SCL SDA GND

1K8 1K8

5v
TX
RX
GND

LCD03

**Sonar Sensors** | **Touch Sensors** | **Compass**

**Battery & Power**

**Control**

**Reset Button**
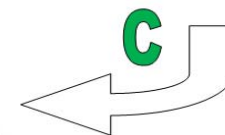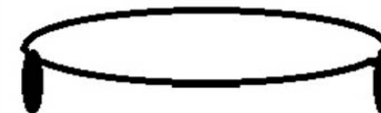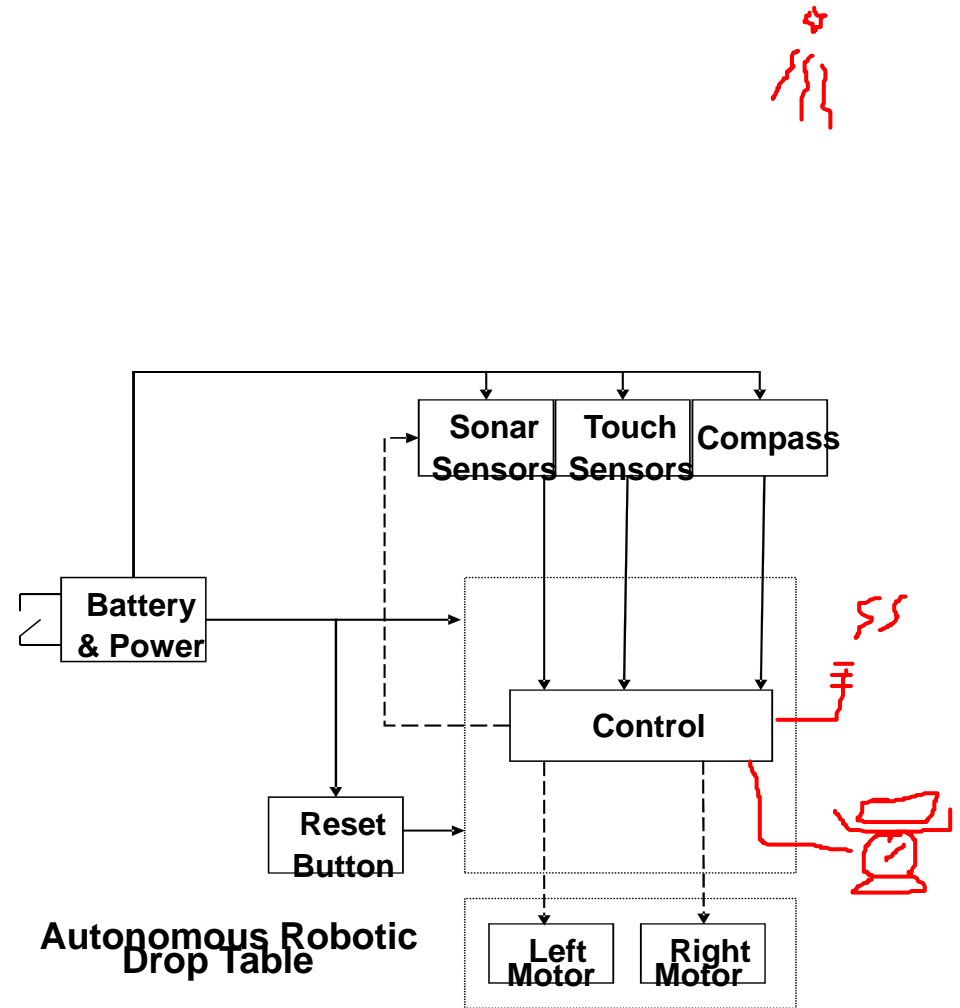
**Autonomous Robotic Drop Table**

**Left Motor** | **Right Motor**

# Implementation

- Hardware design for the autonomous robot
- Building the hardware for the autonomous robot
- Software design for [all] programming: including sensors, weight requirements, homing requirements, etc.
- Software implementation (i.e coding for the atom board)
- System integration -- Assembling of the entire hardware and software
- Test and evaluation

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 14 | BUS | Wheels | NT-2252 | 4 | $9.99 | $39.96 | 3 | Robotmarketplace | http://www.robotmarketplace.com/products/NT- |
| 15 | BUS | Motor (12A) | RB-Ban-71 | 4 | $28.00 | $112.00 | 2 | Robotshop | http://www.robotshop.com/en/banebots-first-cim |
| 16 | BUS | Sonar Sesnsor | 28015 | 1 | $29.99 | $29.99 | 2 | Parallax | http://www.parallax.com/product/28015 |
| 17 | BUS | Weight Sensor (Load Sensor) 50kg | SEN-10245 | 1 | $9.95 | $9.95 | 3 | Sparkfun/Karlsson Robotics/Robotshop | http://www.karlssonrobotics.com/cart/load-sens |
| 18 | BUS | Gyro Sensor | 28526 | 1 | $29.99 | $29.99 | 3 | Parallax | http://www.parallax.com/product/28526 |
| 19 | BUS | Homing Device | 702 | 2 | $49.95 | $99.90 | 1 | Pololu | http://www.pololu.com/product/702 |
| 20 | BUS | Arduino 3S Motor Driver Shield (1.2A) | VUPN5799 | 1 | $24.99 | $24.99 | 1 | Vetco | http://www.vetco.net/catalog/product_info.php?p |
| 21 | BUS | 12V 8A Rechargable Battery with Charger | IK-018049 | 1 | $24.74 | $24.74 | 1 | Cabela's | http://www.cabelas.com/product/Cabelas-Rech |

# Final Product ?



- What went wrong?

# Lessons

- ## Team Formation
  - EE and CpE
  - No Hardware and System Integration Experience

- ## Team Dynamics
  - Did not overcome technical difficulties
  - Did not consider alternative way of solving the problem
  - Lack of commitment
  - Leadership problem

- ## Changes in Design
  - Sought easier path for implementation
  - Did not consider the entire system
  - Frequent design/component change

# Team Formation

- Northrop Grumman Team
- BusboyIII Team
- Possible Recyclable Project
  - Pedometer-Type Energy Harvester
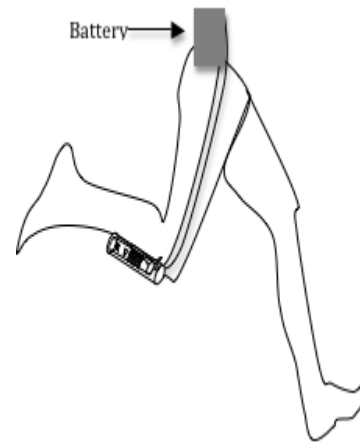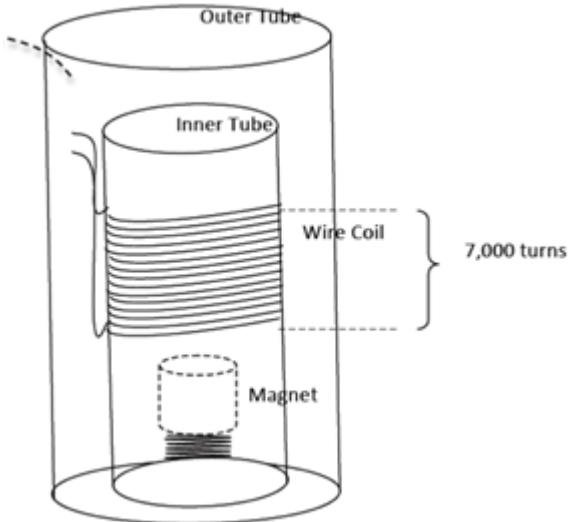
# First Assignment

- www.mwftr.com/SD1415.html

**Assignment #1:** Two circuits I and II shown below in Fig.1 are equivalent. Circuit I, which comprises of a source with a series resistance, is called a Thevenin circuit while Circuit II is called a Norton equivalent circuit to the Thevenin, with a current source of which size is determined by the amount of the voltage in I divided by the resistance in I, and a parallel resistor with the same resistance as in I. Now, a technician built a circuit (I or II) with an actual source and an actual resistor, and put the circuit inside a metal box, and made out the two terminals A and B as in either of the circuits. The problem is how to find which circuit is built and placed inside the box? Think over the problem and provide your solution approach in a typed report, and be ready for a class discussion. **Hardcopy report submission due: 2:00pm 09/10/2014**
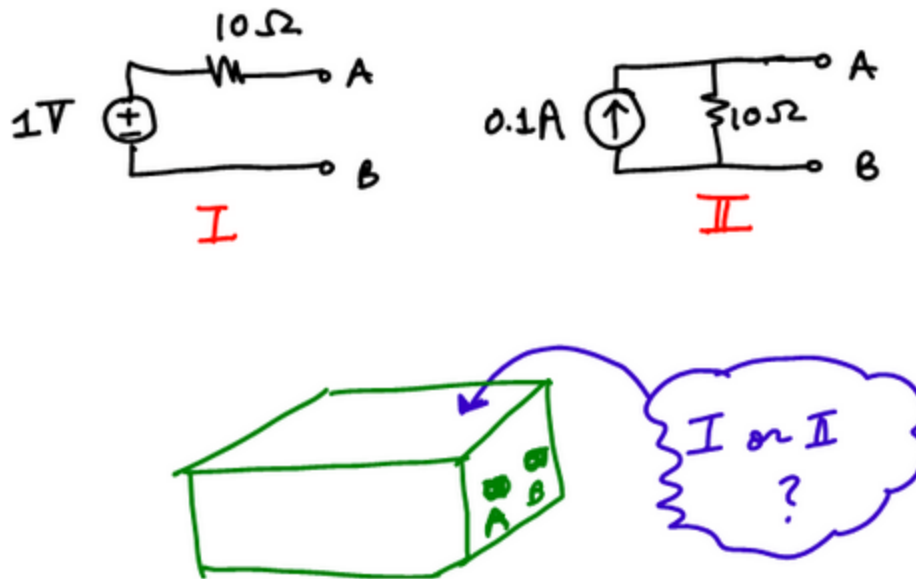


Fig. 1

- Conscious of your thinking process

# How to write well for Senior Design class

- People are more likely to read subjects/writings/emails that create curiosity or provide utility

- When they are busy

  *Curiosity vs. Utility*

  – Curiosity fades in importance

  – They read only the ones with practical importance ["utility"]

- So, write as if you are a staff writer (targeting for busy people) for a newspaper, and remember that you have an editor whose job is to cut your article to fit into a limited space, maybe just 1 inch in a column.

  – Important things [Conclusions and summary] in the first paragraph

    - Summary of the event/thing first so that it delivers message even though only that summary survives the "cutting"

  – Then expand your story after the First Paragraph

  – Use your own words

www.cbsnews.com/8301-202_162-57600384/syria-strike-seems-inevitable-as-u.n-warns-against-unilateral-military-action-hunt-

*Updated at 6:48 a.m. Eastern*

**DAMASCUS, SYRIA** | U.N. chemical weapons experts investigating an alleged poison gas attack near Damascus left their hotel again Wednesday hoping to carry out their second field trip, which was delayed Tuesday for security reasons.

The team of about 20 inspectors left their hotel in the Syrian capital in a convoy of cars to visit the eastern Ghouta suburbs, where the Obama administration says President Bashar Assad's forces unleashed a chemical weapons attack on Aug. 21 that killed hundreds of people.

Local opposition activists told CBS News that the convoy had reached the town of Mleiha, in the sprawling Ghouta area, and videos posted online by the activists showed the U.N. inspectors interviewing patients at clinics in Mleiha and the nearby town of Zamalka.

*Play* **VIDEO**

**Intercepted communications, tissue samples prove Syrian regime responsible for gas attack**

On Tuesday, Vice President Joe Biden made it clear that regardless of what the U.N. inspectors find, the White House is now convinced the attack was carried out by Assad's forces.

The American government's assessment is based on the circumstantial evidence from videos posted on the internet, and, as CBS News correspondent David Martin reported Tuesday, intelligence -- much of it still classified -- ranging from intercepted Syrian communications to tests of tissue samples taken from victims.

Another key piece of circumstantial evidence which has been cited by both officials and analysts for days is the simple fact that the regime is the only entity in Syria known to have chemical weapons and the means to disperse them.

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# With this

By Oliver Holmes and Erika Solomon
BEIRUT | Wed Aug 28, 2013 7:59am EDT

(Reuters) - The United Nations Security Council was set for a showdown over Syria on Wednesday after Britain sought authorization for Western military action that seems certain to be vetoed by Russia and probably China.

U.N. chemical weapons experts investigating an apparent gas attack that killed hundreds of civilians in rebel-held suburbs of Damascus made a second trip across the front line to take samples. Secretary-General Ban Ki-moon pleaded for them to be given the time they need to complete their mission.

But the United States and European and Middle East allies have already pinned the blame on Assad and, even without full U.N. authorization, U.S.-led air or missile strikes on Syria look all but certain, though the timing is far from clear.

That has set Western leaders on a collision course with Moscow, Assad's main arms supplier, as well as with China, which also has a veto in the Security Council and disapproves of what it sees as a push for Iraq-style "regime change" - despite U.S. denials that President Barack Obama aims to overthrow Assad.

Uncertainty over how the escalation of the conflict at the heart of the oil-exporting Middle East will affect trade, and the world economy sent oil prices, and gold, to their highest levels in months while stocks fell. Fears over the economy of Syria's hostile neighbor Turkey pushed its lira to a record low.

**Analysis & Opinion**

Western powers could strike Syria within days

West mustnâ€™t rush into Syrian conflict

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**Related Video**

**U.N. resumes Syria chemical attack probe**
4:20am EDT

Rebels gain ground in Northern Syria

Israel will respond with force to any attack from Syria

Biden: No doubt Syrian regime used chemical weapons

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