Active Window Control Module Preliminary Design Review

By Maxwell Rapier, Andrew Hartnett, Jonathan Townsend, and Damian Gunadasa

HELLO!

Maxwell Rapier
Electrical Engineer

Andrew Hartnett
Computer Engineer

Jonathan Townsend
Electrical Engineer

Damian Gunadasa
Computer Engineer

Shira Epstein
Faculty Advisor

Manhattan 2

Glenn Weinreb - CTO of Manhattan 2

Glenn is the founder and CEO of GW Instruments a manufacturer of data acquisition hardware and software. He has designed approximately 30 commercial systems that connect processors to gadgets within a building. He founded this company in 1985 while an electrical engineering student at MIT. Glenn is experienced with designing analog and digital electronics, writing software, web design, doing mechanical design, raising venture capital (from Sigma Partners), sales/marketing, and manufacturing.

MA2 Manhattan 2

R&D Initiative To Create Low-Carbon Society

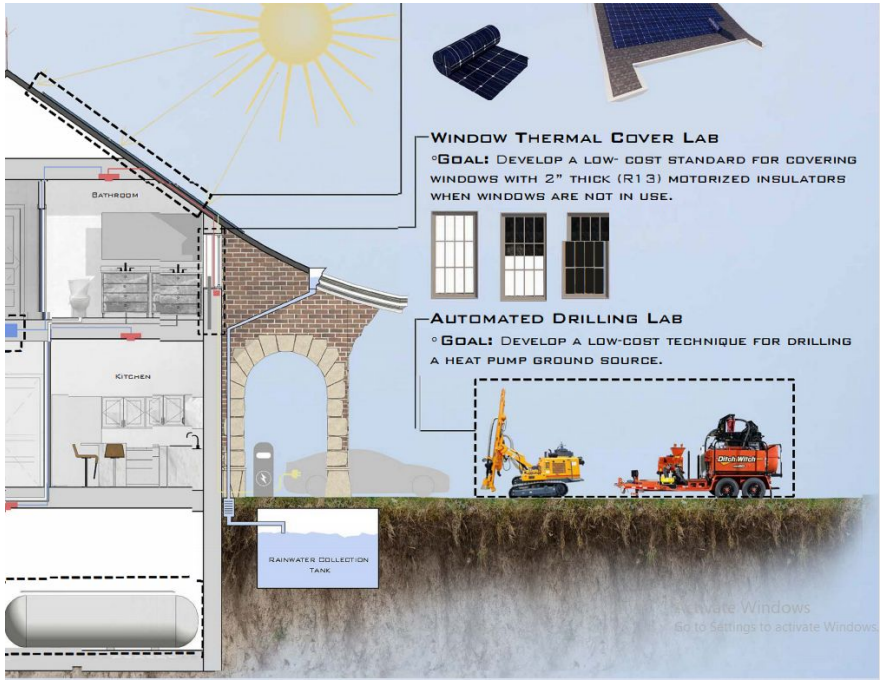
Manhattan 2 - Company looking to develop Active Window

Manhattan 2 is a 501c3 non-profit corporation that mobilizes top scientists to solve large problems that threaten our society. They develop electrical, mechanical, and communications standards that define how low CO2 devices interconnect within the building of the future.

Problem Statement

Background: Smart home technology greatly improves home efficiency. Smart window technology stands to further increase efficiency in terms of power consumption by incorporating sensors that track real time environmental data and by networking sensor data between windows. This allows users to set automated preferences relating to temperature, pressure, humidity and sunlight to create a suitable, personal environment within the home bypassing traditional HVAC solutions

Goal: Design a user interface that controls a system of motors based on environmental data from sensors to regulate indoor environments robustly between windows.



Preliminary System Specifications

The Active Window - Window Primary Control Module will meet or exceed the following system specifications:

1. Supports communication with network via WallBus (CAN Bus)
2. Supports communication with inter-window motors via WindowBus (CAN Bus)
3. Allow the user to set the height at which the window, thermal cover, and blinds are opened/drawn
4. Allow the user to create a time schedule to open/close parts of the window
5. Allow the user to stop smart capabilities of the window, returning it to a simple mechanical device
6. Measure temperature, humidity, air pressure, and light inside and outside the room
7. Display the height at which the window, thermal cover, and blinds are opened/drawn
8. Ability to enter Sleep mode when not being used, can enter Active mode upon user touching screen
9. Volume (LxWxH): 1,536 cubic cm. (12 x 16 x 8 cm) (93.7 cubic in. (4.72 x 6.30 x 3.15 in))
10. Last more than 50 years before needing replacement

Prototype Cost Estimates:
Component Overview

Component	Product Number	Quantity Required	Price
Arduino Uno Rev3	7630049200050	1	$23.00
2.8" Touch LCD Display Shield	RB-Wav-20	1	$19.99
Weather click by Mikroe	MIKROE-1978	4	$22.00
Ambient Click by Mikroe	MIKROE-1890	2	$9.00
Arduino UNO click shield	MIKROE-1581	2	$6.00
Bipolar Stepper Motor Hybrid	1738-1036-ND	1	$14.09
Qunqi Motor Drive Controller Board	L298N	1	$6.69
		Estimate Total Cost:	**$181.77**
		Percent of Budget:	**36%**

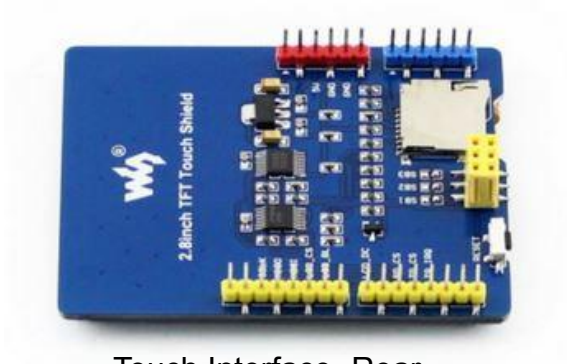
Prototype Components

Light Sensor

Stepper Motor

Weather Sensor

Touch Interface- Front



Touch Interface- Rear

Competing Solutions-**Fenestra Smart Window Technology**

Manufacturer: Fenestra

Product Overview: By automatically opening and closing the windows in your home at precisely the right time, fresh air from the outdoors can circulate seamlessly through your home, flushing out stale and dirty air in the process. During summer, temperatures rise, A/C use increases considerably, as does electricity consumption. fenestra helps cool your home easily and conveniently with fresh morning air. As the day goes by and temperatures begins to rise, fenestra conveniently responds by closing windows.

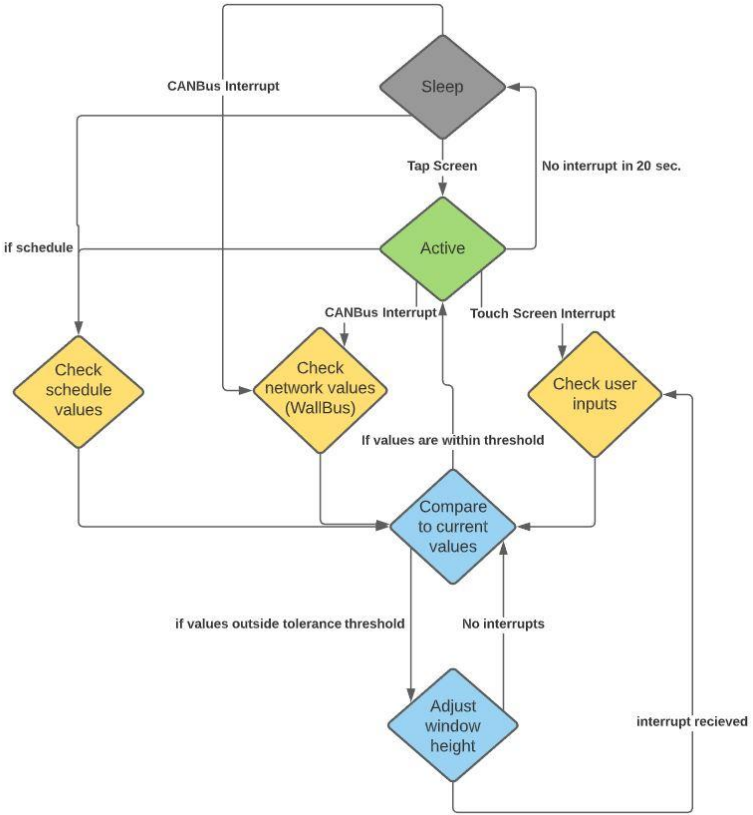
System Specs:
- **Motor**: 6 volt electric motor mechanism.
- **Security**: Temperature and movement sensors onboard.
- **Chipset**: ATMEL® Microcontroller + ZigBee® Radio.
- **Connectivity**: Samsung SmartThings®.
- **Power**: High capacity LiO battery charged by a 6 Watt solar panel.
- **Operation**: Controlled using any smartphone/tablet via the SmartThings® app.
- **Control Range (May Vary):** 325 feet (100 meters).

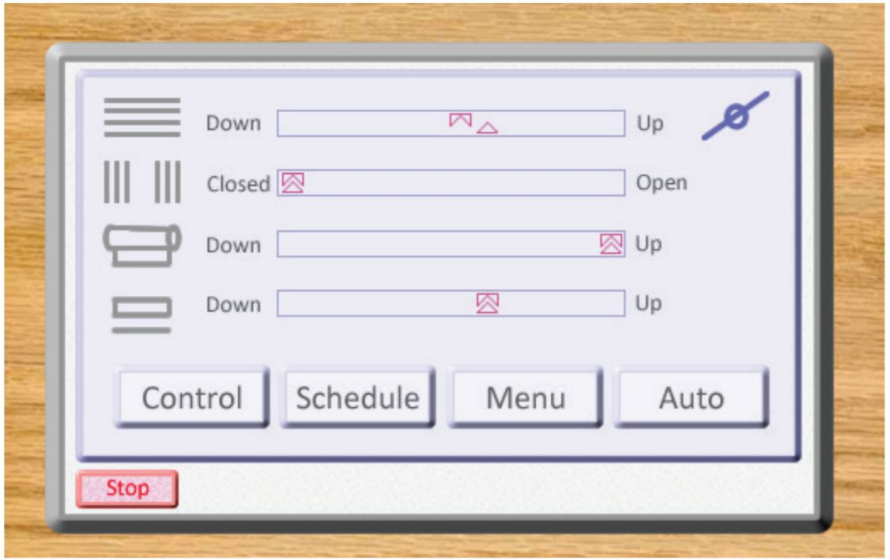
http://www.smartfenestra.com/products

Competing Technology Companies

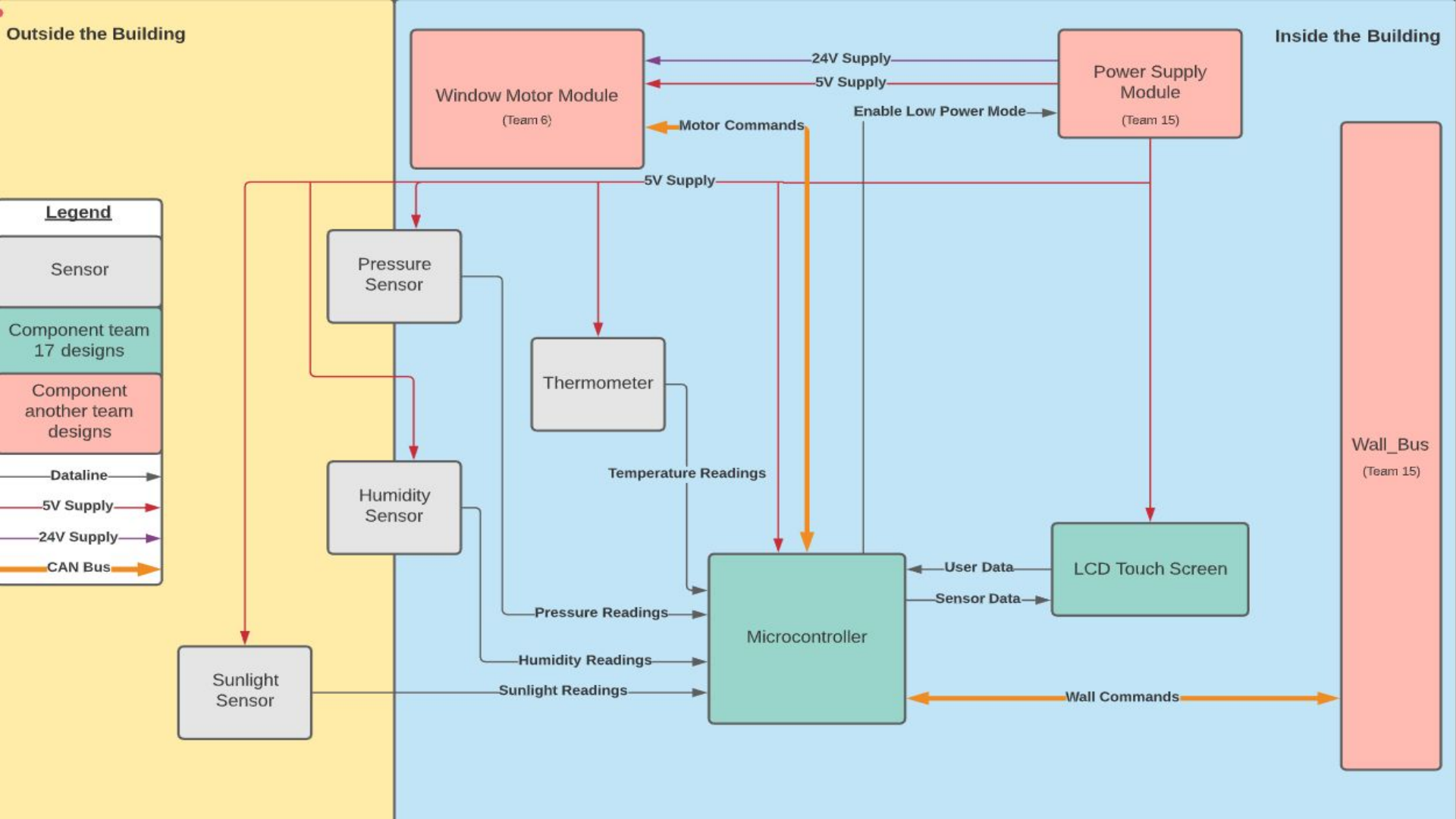
- **HDH Technology** - “Create and build custom automation systems to fit your needs”
  - Motorized Shades and Drapes
  - Services include residential and commercial infrastructure
- **Hogar Controls** - “Smart Home Controllers for A Smarter Everything”
  - Motorized Curtains
  - Automatic Temperature Control
  - Residential, Hospitality and Commercial market
- **SmartThings** - “Easily control, monitor, and secure your home”
  - Smart Thermostats
  - Motorized, controllable smart shades, solar covers, blinds
  - Primarily residential, customizable application

System Software Block Diagram



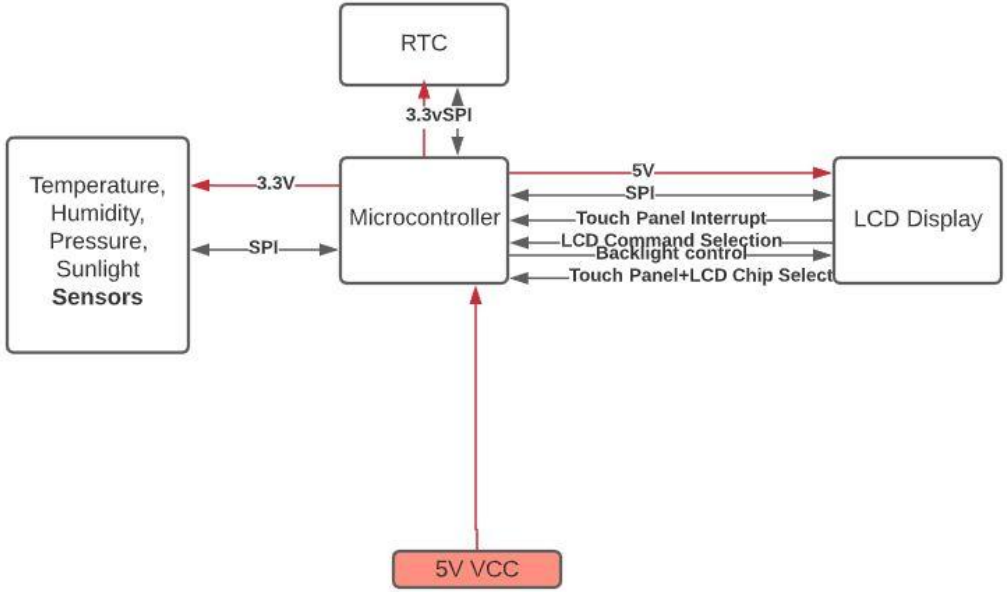


Source: Manhattan2 Active Window Development Initiative


Outside the Building
Inside the Building
Window Motor Module
(Team 6)
24V Supply
5V Supply
Motor Commands
Enable Low Power Mode
Power Supply Module
(Team 15)
5V Supply
Legend
Sensor
Component team 17 designs
Component another team designs
Dataline
5V Supply
24V Supply
CAN Bus
Pressure Sensor
Thermometer
Humidity Sensor
Temperature Readings
Sunlight Sensor
Pressure Readings
Humidity Readings
Sunlight Readings
Microcontroller
User Data
Sensor Data
LCD Touch Screen
Wall Commands
Wall_Bus
(Team 15)

Significant Custom Hardware

- Microcontroller
  - Peripherals
  - Supports SPI, I2C, and UART
- Click boards (Sensors)
  - Weather click, Ambient click
    - SPI Interface
- LCD Display Shield
  - SPI Interface
  - Interrupts
- Real time clock
- CANBus click boards
  - Interface WindowBus and WallBus



MDR Deliverables

Send a message via CAN bus

Demonstrate data to and from the LCD touch screen

Demonstrate we can get readings from each of our sensors

Control Stepper Motor

Finalize parts list and assure system will last 50 years

Technical Responsibilities

Maxwell Rapier ● Team Coordinator ● CANBus	**Andrew Hartnett** ● Technical Lead ● LCD Display
Jonathan Townsend ● Budget Manager ● Motor Driver	**Damian Gunadasa** ● Altium Lead ● Weather click

Overarching Category	Task	Team Member	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
CANBus	Arduino UNO “Hello World”	Max								
CANBus	CANBus Testing	Max								
Motor	Arduino UNO “Hello World”	Jon								
Motor	Stepper Motor Testing	Jon								
LCD	Arduino Uno “Hello World”	Andrew								
LCD	LCD Testing	Andrew								
Sensors	Arduino UNO “Hello World”	Damian								
Sensors	Sensor Testing	Damian								
50 Years	Checking 50 Year Requirement	All								
MDR	Presentation	All								

Thank You!