Design Team Number: P08405

Meeting Purpose: To address design area of 1) Subsystems 2) System architecture and 3) Systems integration 4) Knowledge of Customer and Feasibility

Materials to be Reviewed:

1) Subsystem design and part choices

2) Risk Mitigation

3) Finalized BOM

4) Systems integration and test plan

5) Functional diagrams

Meeting Date: 02/15/08

Meeting Location: RIT Engineering Building—room 09-1129

Meeting time: 1:30pm-3:00pm

Timeline:

Meeting Timeline		
Start time	**Topic of Review**	**Required Attendees**
1:30pm	Sensors, Data logging, Electrical Subsystem	Team, guide, Dr. Kempski,
2:00pm	BOM, System Diagrams, Layouts	Team, guide, Dr. Patru
2:30pm	Risk, integration, and test plans	Team, guide

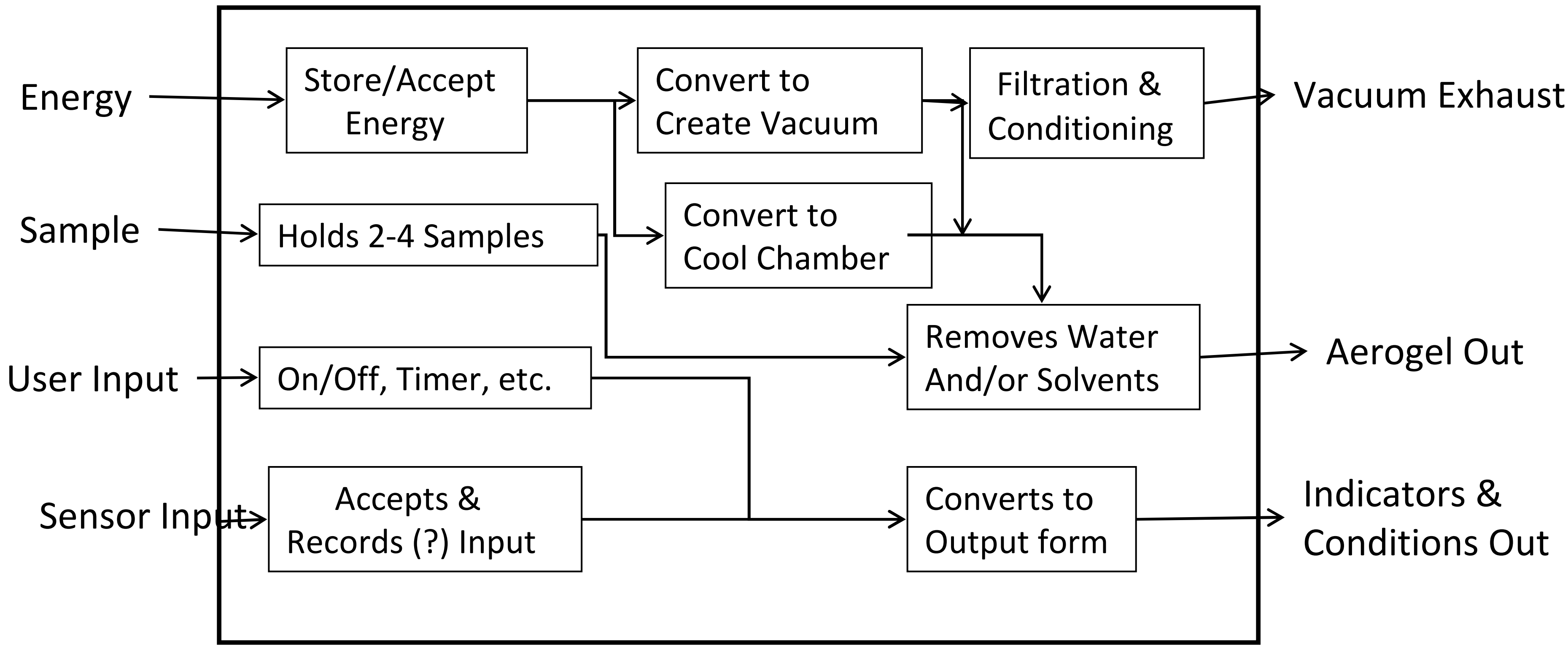
Metric #	Need #s	Metric	Importance	Units	Marginal Value	Ideal Value
1	2,5,10	Chamber Temperature	9	Degrees Celsius	<-20	<-60
2	1,11	Evacuated Atmosphere (vacuum quality)	9	Torr	<4 Torr	<1 Torr
3	7	Mobility	3	Subjective	3	5
4	3	Corrosion Resistance	9	chemical resistivity	moderately	extremely
5	4	Emergency shutoff	3	Subjective	absent	present
6	8,9	Chamber Size	3	cm^3	130-200	200+
7	6	Chamber Pressure accuracy	9	Torr	.x	.xxx
8	9	Sample capacity	1	# of samples	1	3+
9	5	Temperature Monitoring Accuracy	3	Degrees Celsius	x	.xx
10	13,14	System Controls	3	subjective	basic	intregate
11	12	Cooling System Life Cycle	1	subjective	one time use	sustainable
12	15	Compliance with Budget Requirements	9	% of budget used	<100	75-85
13	5,6,16	Upgradability of System	3	# of add-on/upgraded parts	2	4+
14	17	System Power	3	Power Type	120Vx2, 240x1	120Vx1

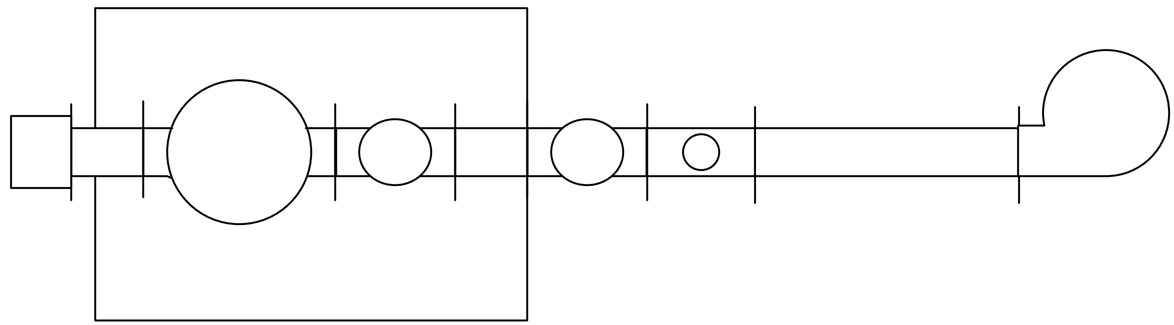
P08405 Itemized Budet

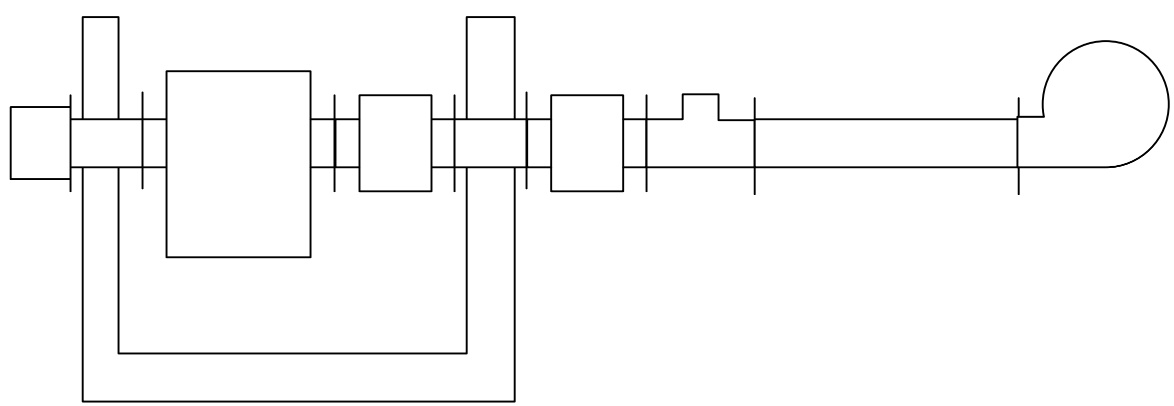
Product	Item/Model #	Supplier	Lead Time	Shipping Weight	Cost	Percentage of Budget	Status
Cooling System							
Freezer	#04616512000	Sears	0 weeks	~88 lbs	$179.99	0.002	pending
Vacuum System							
Vacuum Pump	BOC Edwards E2M1.5	Kurt J.Lesker Company	2-3 Weeks	~25 lbs	$1,450.70	0.161	ordered
Vaccum Chamber	LVC0810NW25-VHE	LACO Technologies	0+ weeks	~15 lbs	$775.00	0.086	ordered
Dry Ice Trap	LIT-1002S	LACO Technologies	0 weeks	~5 lbs.	$675	0.075	ordered
Corrosives Trap	MV300405	LACO Technologies	0 weeks	~5 lbs.	$85	0.009	ordered
Fittings						0.000	
Vacuum lines						0.000	
10" Stainless Flex line (x2)	LVFMHN25x10S	LACO Technologies	0 weeks	~1lb	$104	0.012	
30" Stainless Flex line	LVFMHN25x30S	LACO Technologies	0 weeks	~1lb	$125	0.014	
40" Stainless Flex line	LVFMHN25x40S	LACO Technologies	0 weeks	~1lb	$175	0.019	
Aluminum Flange Clamps (x8)	NW25-100-C	LDS Vacuum Shopper	0 weeks	~1lb	$160	0.018	(x2) ordered
Centering rings (x8)	NW25-100-AR-S	LDS Vacuum Shopper	0 weeks	~1lb	$60	0.007	(x2) ordered
O-rings (x8)	NW25-100-OS	LDS Vacuum Shopper	0 weeks	~1lb	$16	0.002	
4" Solid Pipe (nipple), NW25	NW25-100-NS	LDS Vacuum Shopper	0 weeks	~1lb	$46	0.005	
T-Adapter (1/4" NPT)	NW25x1/4NPT-ST	LDS Vacuum Shopper	0 weeks	~1lb	$75	0.008	
Mobility							
Cart					$250	0.028	pending
Fasteners	multiple				$100	0.011	
Data Logging							
DAQ Unit	NI cDAQ-9172	National Instruments	0 weeks	~2 lbs.	$150	0.017	
Temperature Module	NI 9211	National Instruments	0 weeks	< 1 lb.			
Pressure Module	NI 9201	National Instruments	0 weeks	< 1 lb.			
Thermocouples (2)					$100	0.011	
Pressure transducer					$350	0.039	
Emergency cutoff relays (2)	NI 9481	National Instruments	0 weeks				
				Totals==>	**$4,876.69**	**52.386**	

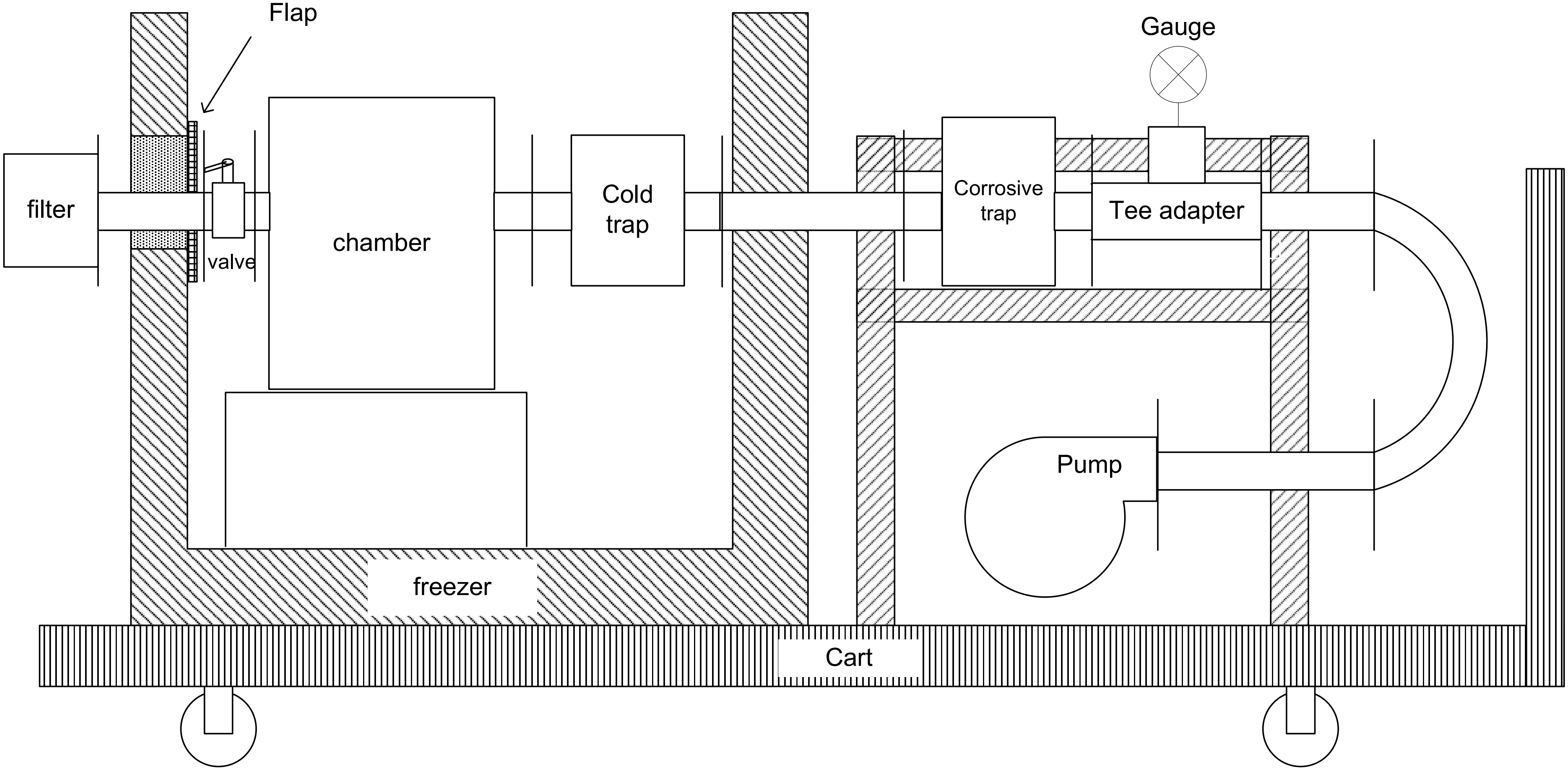
**based on $9000 baseline

Freeze drying Chamber Functional Diagram








Flap
Gauge
filter
valve
chamber
Cold trap
Corrosive trap
Tee adapter
Pump
freezer
Cart

Hierarchy of Needs for P08405

1. Chamber supports a constant vacuum (9)
    - Vacuum pump is sized to chamber (9)
2. Chamber is able to maintain sub-zero temperatures (9)
    - Chamber materials can withstand large temperature variation (9)
3. Pump/chamber/tubing is corrosion resistant (9)
4. Emergency shut off (9)
5. Temperature within chamber is monitored (9)
6. Chamber pressure is monitored (9)
7. Chamber will be mobile (3)
8. Size of chamber (3)
9. Specimens can be separated within chamber (1)
10. Temperature in chamber is able to be controlled (3)
11. Chamber seals must be air tight (9)
    - Supports vacuum pump (9)
12. Cooling system is sustainable (3)
13. System will have a timer (3)
14. System will have an indicator for operational status (1)
15. Budget is not exceeded (9)
16. Pump can adapt to support a second chamber (3)
17. Power to system will be 120V (3)

High Risk Design Areas

1. **Component lead time:** Vacuum pumps in particular require long lead times between order placement and delivery.

    Mitigation: Make early contact with many suppliers, choose supplier based on best combination of price and lead time.

2. **Vacuum pump oil quality**: Vacuum oil is easily contaminated by condensable vapors and/or solvents removed from the chamber. This increases the required frequency of oil changes and reduces service life of the pump.

    Mitigation: Utilize an in line cold trap to remove condensable vapors and solvents before they reach the pump.

3. **System level integration:** Assembly of vacuum chamber, vacuum pump, cooling system, sensors, and data logging system into an operational freeze dryer.

    Mitigation: Detailed planning of system layout (CAD model) and complete BOM of system integration components (vacuum hoses/connections, etc).

4. **Electrical isolation of system components:** Maintaining isolated ground circuits in each component attached to a metal framed cart.

    Mitigation: Use of a cart with an insulating bed material, or the insulation of each connection to a conductive bed cart.

5. **Providing electrical power to all system components:** Accepting 110VAC from wall with a single plug and distributing to system components.

    Mitigation: Use a junction box to safely accept/distribute power. Incorporate current protection (circuit breakers and/or fuses) to protect electrical equipment. Detailed planning through system wiring diagrams, load calculations, etc.

6. **Temperature and Pressure Data Logging:** Maintaining a low sample rate (<<1Hz) record of thermal and pressure conditions within the chamber, without consuming an excessive portion of the overall budget. National instruments modular DACs provide a high level of functionality/adaptability, and associated high cost. Preliminary estimates place the cost of an NI modular DAC system at over $2500.

    Mitigation: Adapt a simpler data acquisition system (such as the USB I/O system used in the Freshmen Seminar program) with our own signal conditioning circuitry for thermocouples and pressure transducers.

7. **Design/testing of custom signal conditioning circuitry:** The use of custom built circuitry will greatly reduce costs, but also increase the complexity of designing/integration into the data logging system.

    Mitigation: The use of integrated circuits for signal conditioning and standardized circuit configurations specified by the IC's manufacturer will greatly reduce the amount of design, and increase the odds that the system will work without significant problems.

Senior Design Team P08405 Integration Plan

1. Clearly define and check power requirements
2. Check fitting types/compatibility on pump, chamber, and traps
3. Choose TI DAQ system and modules to ensure compatibility with Labview software
4. Conduct a Test of all DAQ system parts with a simulated input signal
5. Order chamber with like fittings as pump
6. Elicit expert advice form faculty in this area

Senior Design Team P08405 Test Plan

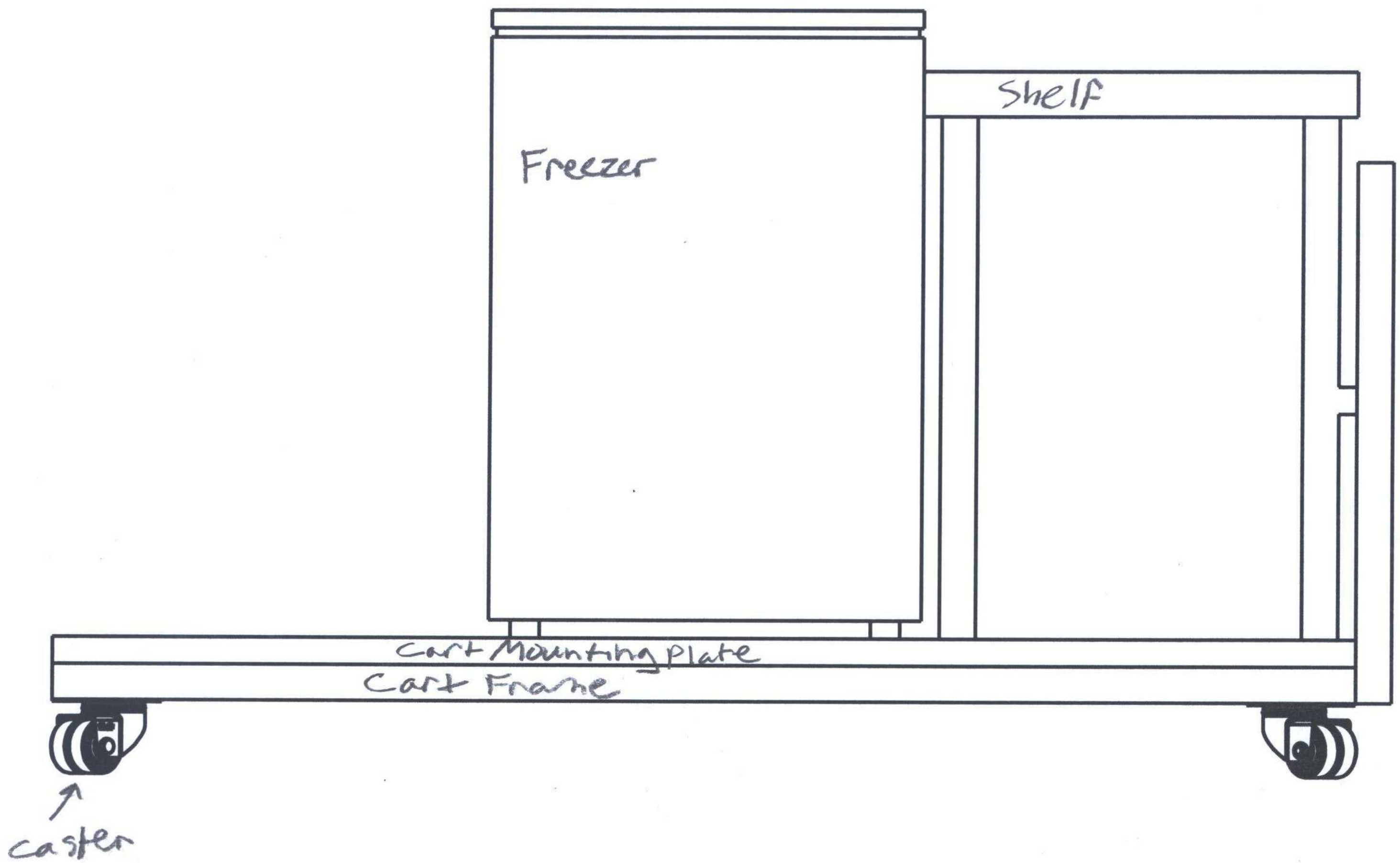
1. Cooling subsystem
    - Run refrigerator for a 5hr cycle to determine operating pressure and current draw
    - Check seals of refrigerator to ensure no leaks are present

2. Vacuum subsystem
    - Leak test all sealed locations of the pump
    - Ensure all fittings are connected correctly and there are no leaks

3. Mobility Subsystem
    - Time system teardown and setup
    - Move system from one lab to another

4. Power and Data Logging subsystem
    - Debug all monitoring software and hardware before use on system
    - Run a simulation with Labview and monitoring systems using a simulated signal input
    - Check all electrical connections to ensure continuity and eliminate shorts
5. Total System Architecture
    - Test Run of system for a 20 hour duty cycle
    - Create aerogel as final proof on concept for system
    - Observe system for first few hours to ensure correct operation

General CAD Layout



P0845 Senior Design Team
Matthew Wavrek
Forrest Svingala
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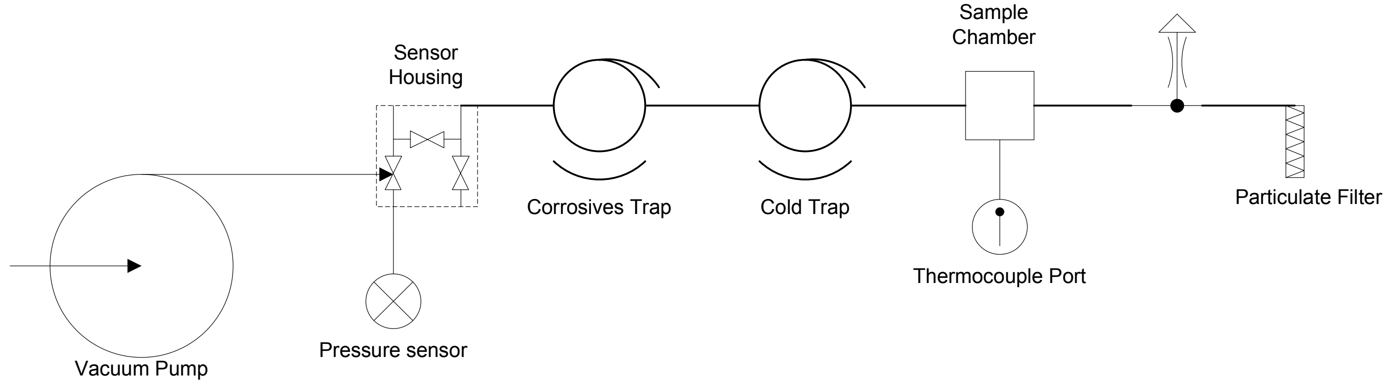
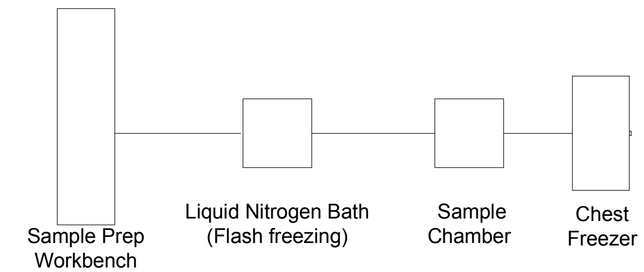
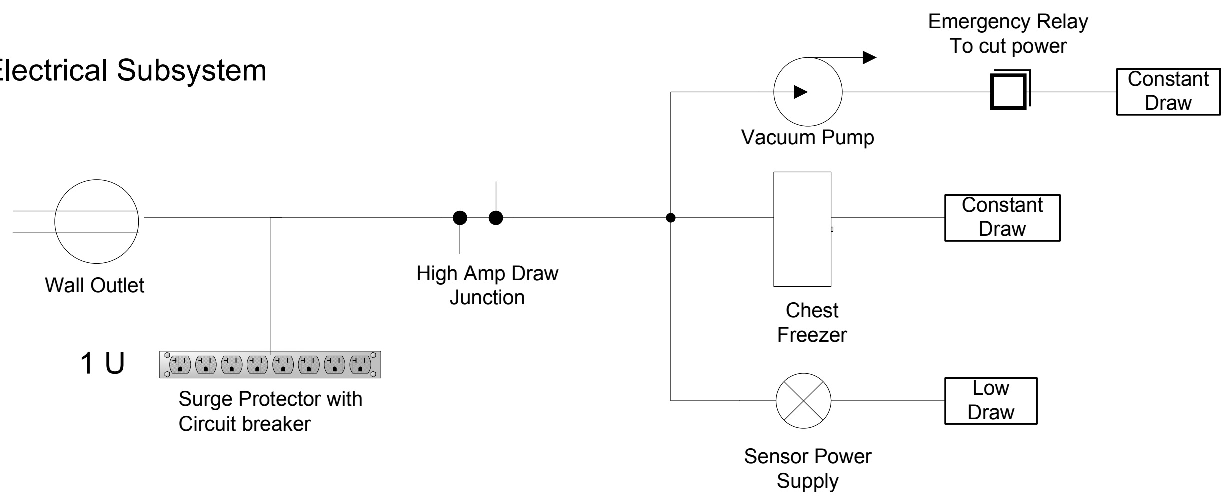
Pump/Vacuum Subsystem



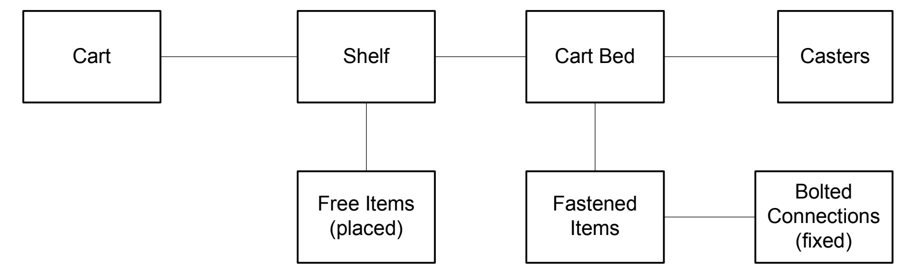
Cooling Subsystem



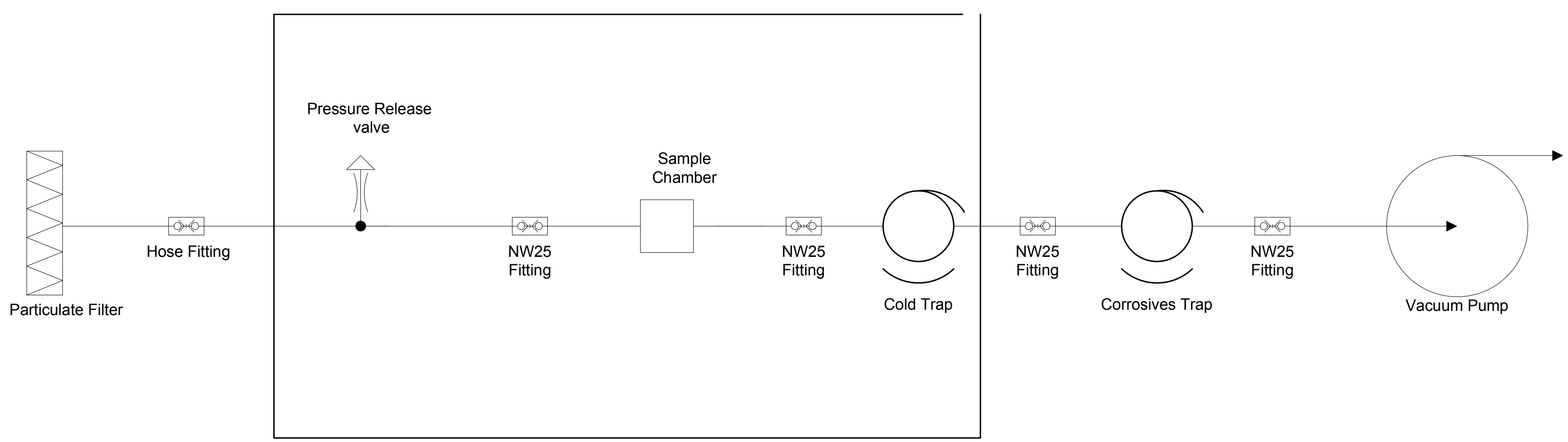
Electrical Subsystem



Mobility Subsystem

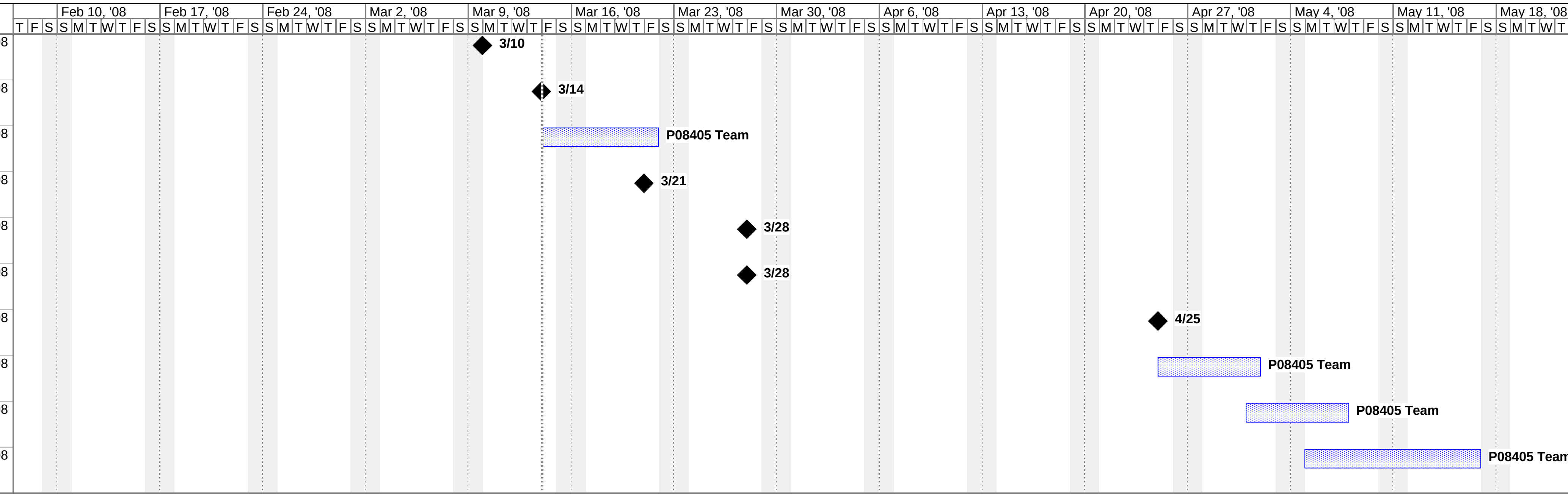


System Architecture



Area Inside Chest Freezer

ID		Task Name	Duration	Start	Finish
1		Senior Design II Begin	0 days	Mon 3/10/08	Mon 3/10/08
2		Lingering Design Issues Fully Resolved	0 days	Fri 3/14/08	Fri 3/14/08
3		Write Assembly & Test Plan	6 days	Fri 3/14/08	Fri 3/21/08
4		Begin System Assembly	0 days	Fri 3/21/08	Fri 3/21/08
5		Begin 1st Draft of Technical Paper	0 days	Fri 3/28/08	Fri 3/28/08
6		Begin Work on Poster	0 days	Fri 3/28/08	Fri 3/28/08
7		System Assembled	0 days	Fri 4/25/08	Fri 4/25/08
8		Execute Test Plan	5 days	Fri 4/25/08	Thu 5/1/08
9		Evaluate performance, make adjustments as needed	5 days	Thu 5/1/08	Wed 5/7/08
10		Prepare Project review presentation	10 days	Mon 5/5/08	Fri 5/16/08



Project: SD II Plan rough
Date: Fri 3/14/08

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	