KGCOE MSD I **Technical Review**

Meeting Purpose : Propose initial design of P11301 for preliminary review and feedback from customers, key faculty, and peers.

Materials Reviewed : All existing documentation and designs on the project including project background and introduction, customer needs and specs, risk assessments, customer weighting, and sketches

Attendees:
Mike DeMayo (Project [admin] Manager)
John Mathews (Mechanical Design Engineer)
Professor Slack (Design Team Mentor)
Dr. Landschoot
CIAS Students
David Watkins (Design Manager)
Ben Sheron (Electrical Design Engineer)
Professor Marla K. Schweppe: (Project Sponsor)
Dr. Hoople
Fellow SD students

Recorded by :John Mathews ___________________________________ (signature)

Meeting Date: October 8th, 2010 3:30pm

Meeting Location: Xerox Auditorium

Meeting Timeline

Start Time	Topic of Review	Required Attendees
3:30	Background and Introductions	All
3:45	Current Documentation	All
4:00	Structural/Fluids/Trough Design	ME Specialists/Sponsor
4:30	Controls/Power Discussion	EE specialists
4:45	Closing Thoughts	All

Project #	Project Name	Project Track	Project Family
11301	Water Falls Media	Autonomous Systems and Controls	None
Start Term	Team Guide	Project Sponsor	Doc. Revision
2010-1	George Slack	Marla K. Schweppe	1

Project Description

Project Background:

This project was inspired by Marla K. Schweppe and the College of Imaging Arts and Sciences . The project will be a hybrid between projection displays and artificial waterfall displays. The engineering design team will design and build an apparatus that can easily be configured with a projector to display the desired images by the customer.

Problem Statement:

The idea for this project is to design a display waterfall that gives the operator the ability to modify the way the water flows and also to control a projector to project images onto the waterfall. The liquid used needs to be translucent enough to be easily projected upon. The machine must also be able to be completely self contained and portable. The water sheet size must also be large enough end proportioned correctly to accommodate the display of the projector.

Objectives/Scope:

1. The main objective is to create a large enough waterfall (4-8 feet wide) to be used effectively as a screen for a 16:9 projected image in a safe, self-contained, and portable system.
2. The user will have a way of controlling the waterfall by restricting segments of it, allowing for various effects.
3. The user will have an effective means of controlling the waterfall, via a Python library.

Deliverables:

- A self-contained, apparatus capable of producing an aesthetically pleasing laminar waterfall between 7 and 10 feet wide, onto which a 16:9 image can be projected using a suitable projector.
- The ability to turn segments of the waterfall on and off in order to achieve various effects, and an appropriate interface to allow the user to control this function.

Expected Project Benefits:

- The project will provide an attractive, novel means of displaying projected images, utilizing a controllable laminar waterfall.
- The unit will be large enough to be effective, yet self-contained and able to be used in different locations.
- A user with a basic understanding of Python programming will be able to take advantage of the ability to cut off segments of the waterfall, allowing for various creative water effects in conjunction with the projected presentation.
- The project will provide a platform for future development and enhancement if desired.

Core Team Members:

- Michael DeMayo (Project [admin[Manager)
- David Watkins (Design Manager)
- Ben Sheron
- John Mathews

Strategy & Approach

Assumptions & Constraints:

1. Laminar flow must be maintained as much as possible during the water free fall.
2. Translucent liquid must be applied to provide a better projection surface.
3. Electric pumps will be used to move the water from the catch basin to the pouring trough.
4. The water fall sheet must have an aspect ratio of 16:9 in order to match the aspect ratio of the projector.
5. A standard 2500 or 6000 Lumin projector will be used to project onto the water fall sheet.
6. Portions of the waterfall must be able to be blocked off to allow for various water effects.
7. A straightforward method must be provided to allow the user to control the waterfall via software.

Issues & Risks:

- Minimizing turbulence in the water flow to the degree that it is usable as a projection screen will be difficult.
- Water on its own may be too translucent for use as a screen in most lighting conditions.
- For example
    - The lead time of component ABC is 10 weeks.
    - The casting process has been shown over the last two projects to be one of the greatest challenges and will be a key technical hurdle to overcome for the success of the project.

No one on the team has a strong fluid mechanics background so analysis of the flow in subsystem EFG will require external consultation.

Revision #:	1		
Customer Need #	**Importance**	**Description**	**Comments/Status**
CN1	1	safety	Must be safe to have left out running in public
CN2	2	user friendly	documentation and a good interface need to be made
CN3	3	reliability	must have no common errors or faults
CN4	4	looks	must be able to have modifications and accessories added to it
CN5	5	self contained	can be moved and set-up in various display locations
CN6	6	simple	no over-sized load motors or hoses
CN7	7	quiet	can be in a lobby without being a nuisance / Solenoids must be silent
CN8	8	water curtain consistency	water falling needs to be controlled
CN9	9	size/shape	the water fall area is about the size and shape of a whiteboard
CN10	10	no mess	water can't be spraying everywhere
CN11	11	Fluid conducive to image projection and safe	must be non-toxic and be able to have an image projected on it
CN12	12	Python Library	library must be able to be manipulated so that it is visually appealing

Rev #:							
Engr. Spec. #	**Importance**	**Source**	**Specification (description)**	**Unit of Msmnt.**	**Marginal Value**	**Ideal Value**	**Comments/ Status**
ES1	High	CN9	Must be between 5-10 feet wide	Feet	5ft, 10ft	8 feet	
ES2	High	CN9	16:9 Aspect Ratio for projection onto waterfall	ft/ft	17:8 AR	16:9 AR	
ES3	Medium	CN4	Laminar Flow Water Stream	-	reynolds #	< 2300	
ES4	Medium	CN4	Concealed Pumps (as much as possible)	-	-	-	
ES5	Low	CN2	3" poly wheel for maneuverability	inches	2"-5"	3"	
ES6	High	CN5, CN10	Oversized catch trough to account for splashes	in^2	TBA	TBA	
ES7	High	CN11	Safe fluids used	-	-	non-toxic	
ES8	High	CN11, CN4	Fluid viscosity 20cp < v < 40cp	centip osse	20 < v <40	30 centiposse	viscosity cannot interfere with pump

MSD Project Risk Assessment Template

ID	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action/Minimize Risk	Owner
1	Unable to achieve a laminar water fall.	The desired projection screen effect would not be attainable.	The liquid being used to achieve the effect would be moving too turbulently to achieve a pleasant and usable water fall.	2	2	Reduce	Test and design a pouring spout that would most effectively create a laminar water fall.	DeMayo, Mathews
2	Servo “dam” is unable to control the water fall flow effectively.	The waterfall would be one standard size at all times and would not be able be manipulated with any special effects.	The water will surge around the servo “dams” and create turbulent patches at the ends of the waterfall that would cause the entire sheet to be turbulent.	2	2	Reduce	Design a water stopper that wouldn’t cause the water to surge around the “dams” creating a severely turbulent flow.	DeMayo, Mathews, Watkins, Sheron
3	Unable to provide a usable interface to control special effects.	There would be no way to modify how the water is controlled to adjust the projection image.	An interface port and/or interface software /hardware would be absent or non-functional on the device	1	2	Reduce	Ensure that the interface design is incorporated early in the design process.	Sheron, Watkins
4	Unable to create a self contained water cycle.	Leaking and/or not catching the water efficiently into the catch trough.	The water being pumped up to the upper trough is either unable to keep up with the water being poured or too much water will be pumped to the upper trough.	2	1	Reduce	Create a catch trough that will reduce water loss due to splashing and also ensure that the pumps being used will be able to maintain an efficient water cycle.	DeMayo, Mathews
5	Unable to shield the circuitry from the water effectively.	There would be a possibility of electrocution and/or failure of electrical components of apparatus.	There would be an inability to separate the water from the electronics.	1	3	Prevent	Ensure by design that the electrical components are sufficiently isolated from any possible water contact.	DeMayo, Mathews, Sheron, Watkins
6	Structural instability causing the entire device to collapse.	The entire machine would be destroyed because of a structural failure.	Insufficient structural support and/ or material selection could cause the entire machine to collapse.	1	3	Prevent	Ensure by design that the structure will be capable of supporting both the static and dynamic loads from the machine and the fluid.	DeMayo, Mathews
7	Fluids used are hazardous	The fluid used could is hazardous if touched or ingested	The fluid being used is toxic or poisonous	1	3	Prevent	Ensure that the fluid be used would not harm a person if accidental ingestion occurs	DeMayo, Mathews

Technical Specifications and Customer Needs

Customer Requirements	Customer Weights	Catch Trough receives the fluid	Pump Cycles the Fluid	Water Curtain is Laminar	Trough Length	Support Structure	Shape of Water Curtain	Noise Reduction in Place	Self Contained	Projects Image	Fluid Used	Total
Safety	9	1		1		9	1	3	3		9	27
User friendly	3	3	3			9	3		3	9		30
Reliability	3	1	3	1		9	3			9		26
Looks / aesthetics	1	9		9		3	9	3		9	9	51
Self Contained	3	9	1			3		1	9			23
Low Maintenence	3	3	3			3			9			18
Quiet	1	1				1		9	3			14
Constant fluid flow	3		1	9			9					19
Size and Shape	9			1	9	3	9			3		25
Tech. Targets		no spill	reusable liquid	laminar flow	8' length	rigid	aspect ratio	decibels are as low as possible	assemble and dis-assemble in 15 min	Able to project on it.		
Tech. Bench-marking	Better - 5 Worse -1											
	Raw Weight	27	11	21	9	40	34	16	27	30	18	233
	Relative Weight	11.59%	4.72%	9.01%	3.86%	17.17%	14.59%	6.87%	11.59%	12.88%	7.73%	100.00%

Structural Design Ideas

- For a weir that is between 4 - 8 feet wide the ideal volumetric flow rate is 7.7 gal/min which means that the maximum amount of water that the upper trough will be holding is approximately 75-150 pounds between the aluminum trough, fluid and the servos that will be controlling the flow of the fluid over the falls.
- The support structure will be as simple as possible.
- The customer has requested that the entire device (including the support structure) be able to accommodate for aesthetic additions.
- Aluminum would be the preferred material to use for the support structure because of its strength to weight ratio.
- Each side of the structural metal should be a simple A-frame design for strength and mobility.
- 2.5” - 3.0” diameter aluminum tube will be used for the main support members.
- At the bottom of the structure, will be a trough where the pump is mounted, so the water will be caught in it and recycled through the system.
  - we plan on using splash guards and sponges in this to reduce noise and water waist.

Fluids Ideas

- The purpose of the curtain being formed by this device is to provide a surface for projecting images from an external projector.
- The shape of the curtain has been dictated 16:9 aspect ration of the projector. This means that the curtain should be between 8 and 4 feet wide, and between 4.5 and 2.25 feet high, depending on feasibility.
- The fluid to be used in this apparatus needs to be viscous and have sufficient surface tension to ensure that the flow of fluid forms a laminar curtain.
- Water is not the ideal fluid because its viscosity is too low to maintain a completely laminar flow for the entirely of the 2.25 - 4.5’ free fall.
  - Additives like Titanium Dioxide would add the required viscosity however it would make the the fluid abrasive and would damage the pump internals.
- Ethylene glycol and dawn dish soap would provide the ideal viscosity and surface tension however, it is not environmentally friendly and potentially deadly if accidentally ingested.
- For the ideal flow rate the volumetric flow rate is approximately 7.7 gallon / minute, or 2 square centimeters per unit length.
  - There are many pumps readily available that can handle this flow rate and also the 2.25 feet - 4.5 feet of head required by the system.
- We must make sure that whatever chemicals, or materials we add to the water, that is is still safe enough to be able to have running unguarded open to the public. A good measure of safety, would be if a child stuck their hand through the curtain, then put their hand in their mouth, would they get sick from it?
  - A good liquid to use would be one similar to engine coolant, but given its chemical composition, it would be too poisonous to use in the water fall.

Trough Configuration

- The waterfall device will be have two troughs, one for receiving the fluid and one for pouring the fluid, acting as a weir.
- The purpose of the upper trough is to collect water in a basin which will collect the water as calmly as possible. This will be accomplished by using baffles around the edges of the trough to calm the fluid as much as possible. As the water level in the basin rises it will eventually reach the lip of the weir and be poured down to the catch trough. The weir needs to be shaped such that the fluid is dumped as laminar as possible.
- The upper trough will also support an array of solenoids/ servos that will act as a series of remotely controlled dams that will either block or allow the water to be poured from the weir.
- The lower trough will need to be much larger that the upper trough in order to account for any fluid splashing out when it lands. This could possibly be avoided using baffles to break the fall of the water before it simply splashes down.

*for more information, view reference sketches in the back of the packed

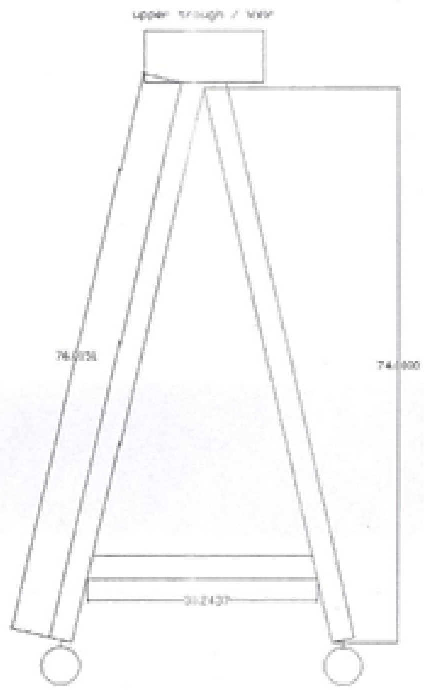
Controls Ideas

- Electrically controlled servos will be used to block off segments of the waterfall, with as many as practical to provide for fine-grained control.
- The control system must allow for the waterfall to be controlled via software on a host PC.
- The host PC will communicate with a main controller, which will then communicate via RS232 to some number of smaller microcontrollers, one for each solenoid - the main controller would only transmit, and the individual servo microcontrollers would only receive.
- The main microcontroller should be large enough that future devices can be interfaced, eg RGB LEDs.

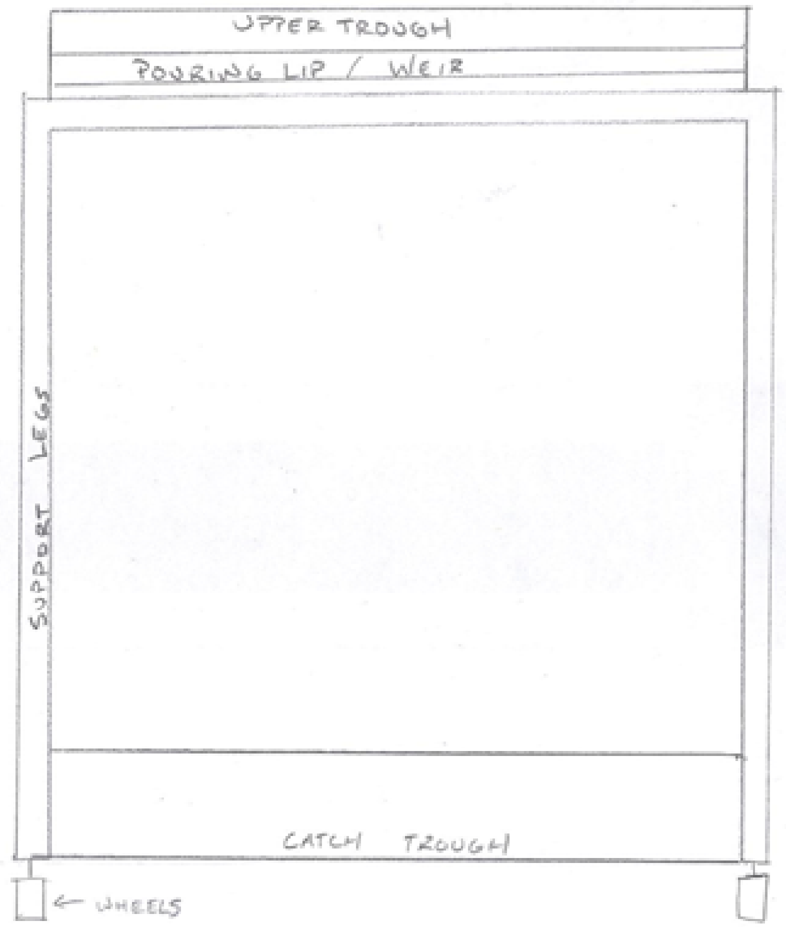
Power Ideas

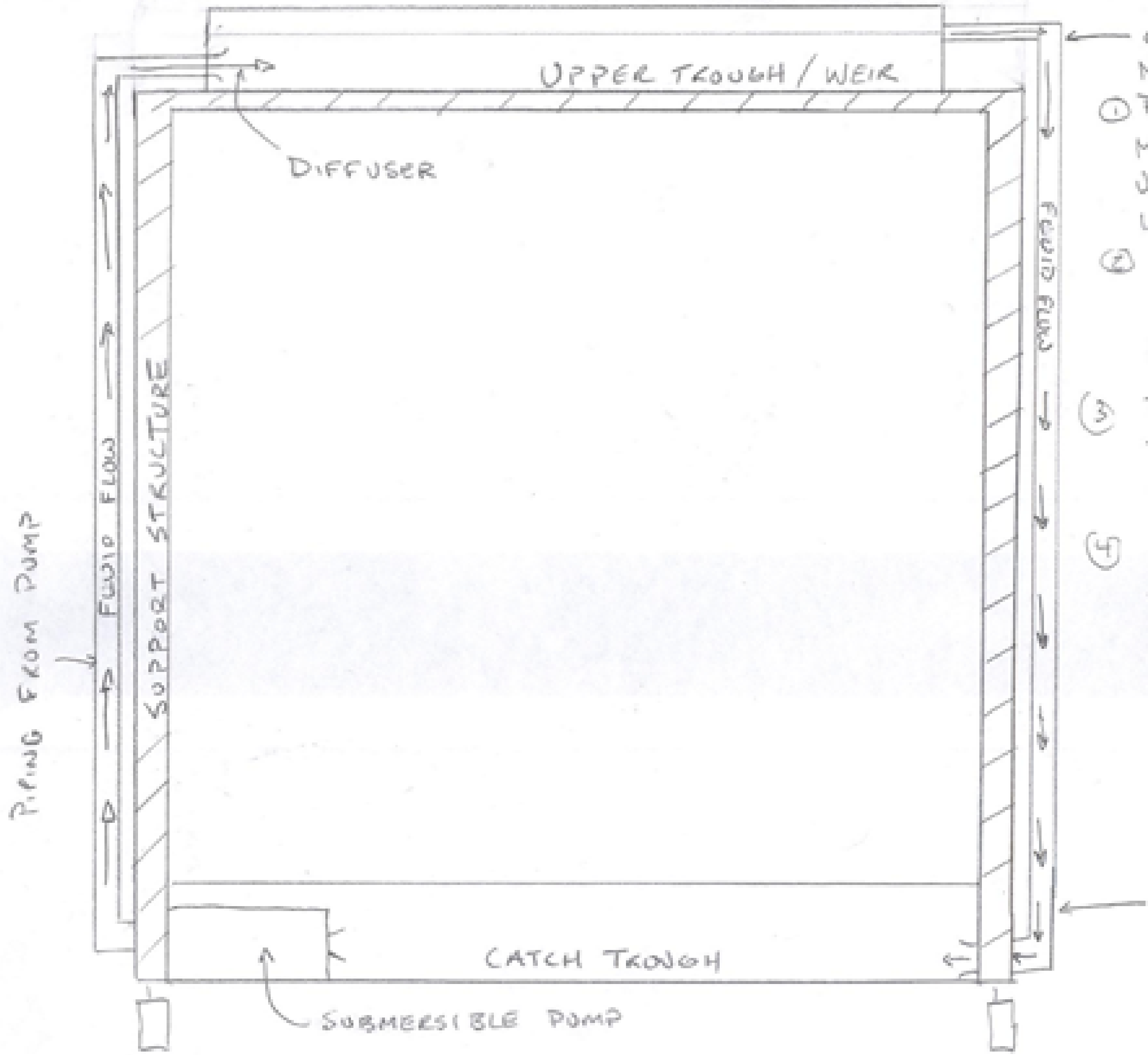
- The water pump will simply run off of standard 60 Hz, 120 VAC mains power.
- The servos and controls will each have separate power supplies.
  - The servos will run on 36 VDC, in order to allow for smaller wires.
  - The control system will run on a 12 VDC supply, to be stepped down to lower voltages as needed via linear regulators.
- Power supplies used can be readily-available, off-the-shelf models.
- Special attention will be paid to over-current protection and general electrical safety issues.

*for more information, view reference sketches in the back of this packed



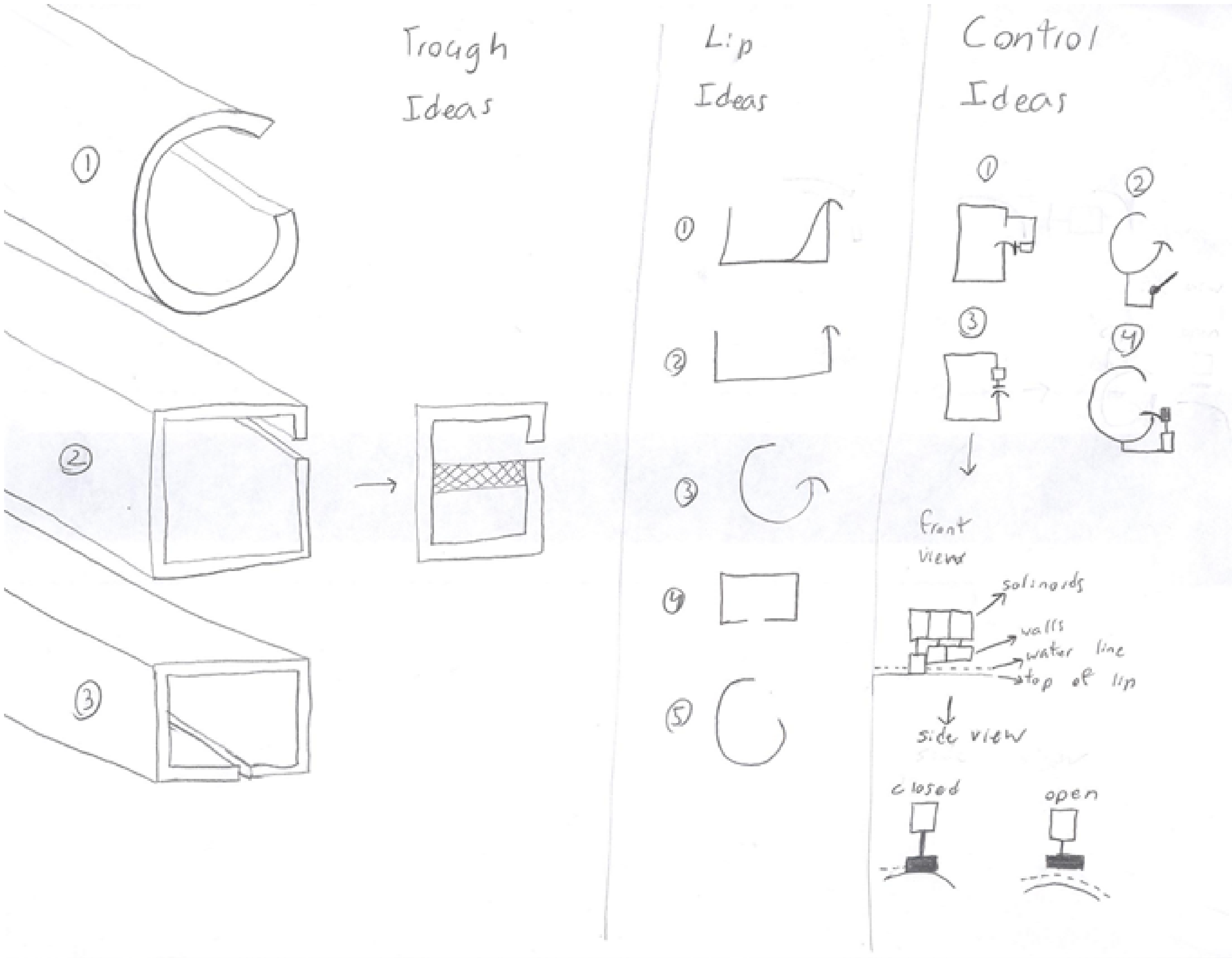
NOTE: SUPPORTS WILL BE ALUMINUM TUBE

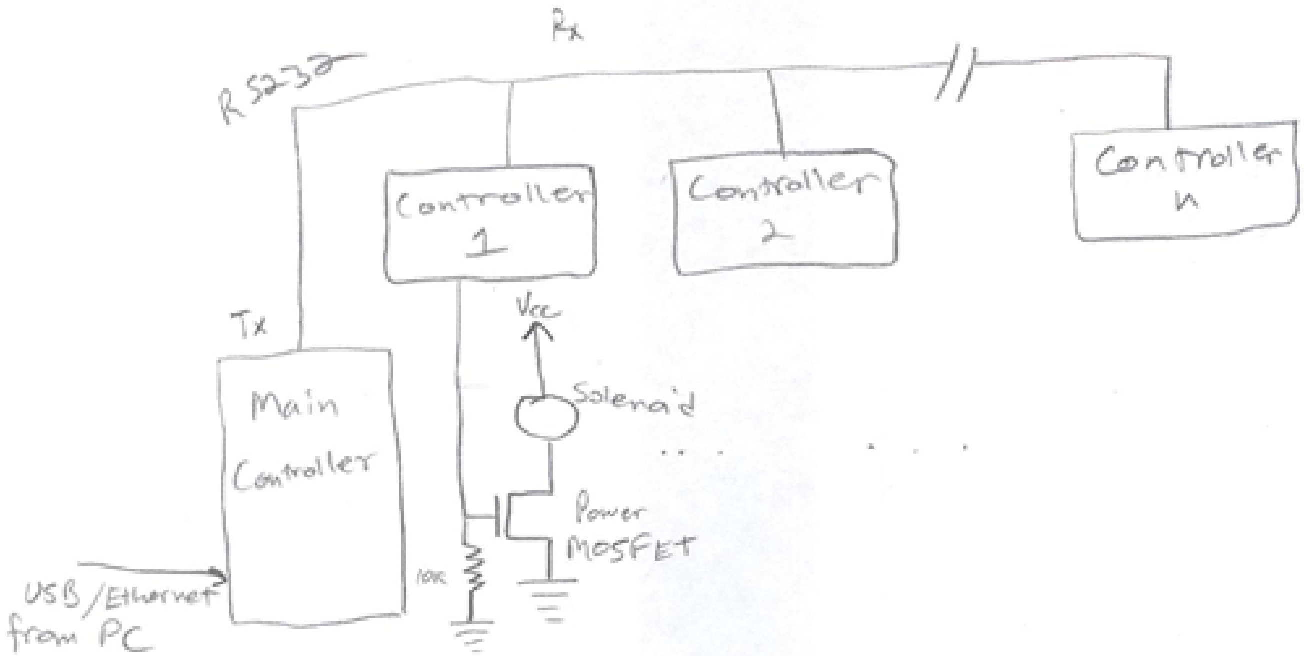




NOTE:

1. PUMP MUST BE ABLE TO MOVE 7.7 gallon/minute IF UPPER TROUGH IS 8 FT WIDE
2. HEAD OF PUMP REQUIRED WILL BE DETERMINED ONCE SIZE IS FINALIZED.
3. PIPE DIAMETER WILL BE DETERMINED BY DISCHARGE OUTLET OF SELECTED PUMP
4. PIPING ENTERING THE UPPER TROUGH WILL BE A DIFFUSER.


Trough Ideas
1
2
3
Lip Ideas
1
2
3
4
5
Control Ideas
1
2
3
4
front view
solinoids
walls
water line
top of lip
side view
closed
open


Rx
RS232
Controller 1
Controller 2
Controller n
Tx
Vcc
Main Controller
Solenoid
Power MOSFET
10k
USB/Ethernet from PC