Un-Cloggable Pump

by

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Un-Cloggable Pump
For Residential Use

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ABSTRACT

The problem with modern day water pumps is that once they get clogged with debris, the pumps will slowly stop pumping the water out of the desired area and their effectiveness is lost. A pump that will help prevent the debris from getting clogged will be ideal for water pump applications.

This report includes supporting information for this design including market products and research. A research document is included in the Appendix that shows the related products on the market to the design prototype. A survey was developed to evaluate what was important for the customer in the design. From the survey, results were established in order to rank the importance of the customer design criteria. From the survey a QFD diagram was developed to determine the relationship from the customer requirements to the engineering characteristics.

A schedule was also developed to insure that the focus of the project was on time and in order. Also a budget was established so that the project financing would stay within budget. All these diagrams can be found in the Appendixes located in the table of contents.

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INTRODUCTION

The problem with modern day water pumps is that once they get clogged with debris, the pump will slowly stop pumping the water out of the desired area and the effectiveness of the pump is lost. I had to face this problem with my fathers pool cover, every spring when its time to open the pool we would have clogging issues with the pump. We would try to remove the water from the cover but it will be filled with debris and would not efficiently work. A pump that will help prevent the debris from getting clogged will be ideal for water pump applications.

Most of the pumps are designed to pump water out of a certain area that just contains water, and if there is dirt and debris in that area the pump efficiency will work at a minimum. The all condition pump was designed to pump the water fluid out of any area, even if there is a large amount of debris around the pump and to maximize the efficiency of the pump.

PRODUCTS ON THE MARKET

A pump is a general product that can be modified in many ways to achieve what application is needed. They come in many types and sizes, the design that will be focused on will be submersible general purpose pumps. Some of the basic components in the pump configuration are the pump head, pressure head, impeller, and efficiency. The main emphasis on the pump design will be the filtration method. The general scheme of this system will be designed using an advanced filtration system incorporated with a method to remove the debris from entering into the pump system.

A submersible pump, like the one seen in Figure 1, is a pump which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The advantage of this type of pump is that it can provide a significant lifting force as it does not rely on external air pressure to lift the fluid.

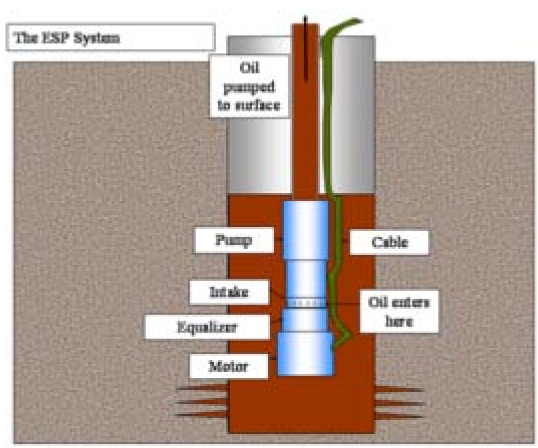


Figure 1-Submersible Pump

In Figures 2 and 3, pumps are shown that accomplish the tasks of pumping water with about a 2 inch discharge per each pump. Currently on the market there are no pumps that accomplish the same tasks that the new pump design will accomplish. Many of the pumps on the market are distinguished by pump size, pump speed, and frame resistance to weather conditions.

Figure 2-Pump design

Figure 3 – Garden Pump with hose attachments

There are also designs in the market that act as a pump and cleaner system in one (Shown in Figure 4 &5). The new TetraPond OFX Open-Flow Debris-Handling Pump is specifically designed to clean the pond as it pumps. The OFX Pump sends debris-laden water to an external filter without clogging. The innovative cage design allows debris up to 3/8" to pass through the perforated shell to a specialized rugged impeller, which forces the debris to the ponds' external filter where it is easily removed. No messing with pre-filters, just put the OFX in you pond and let it do its job-cleanly and efficiently, but the problem with this pump is that it operates in a closed system were as the new design is in an open system.

Figure 4-Debris handling pump

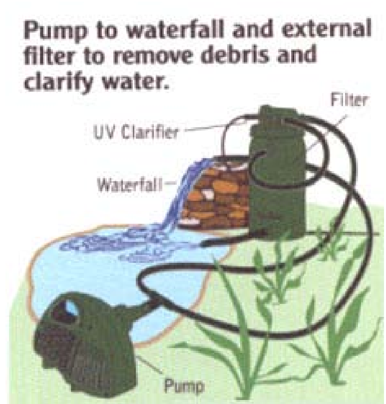


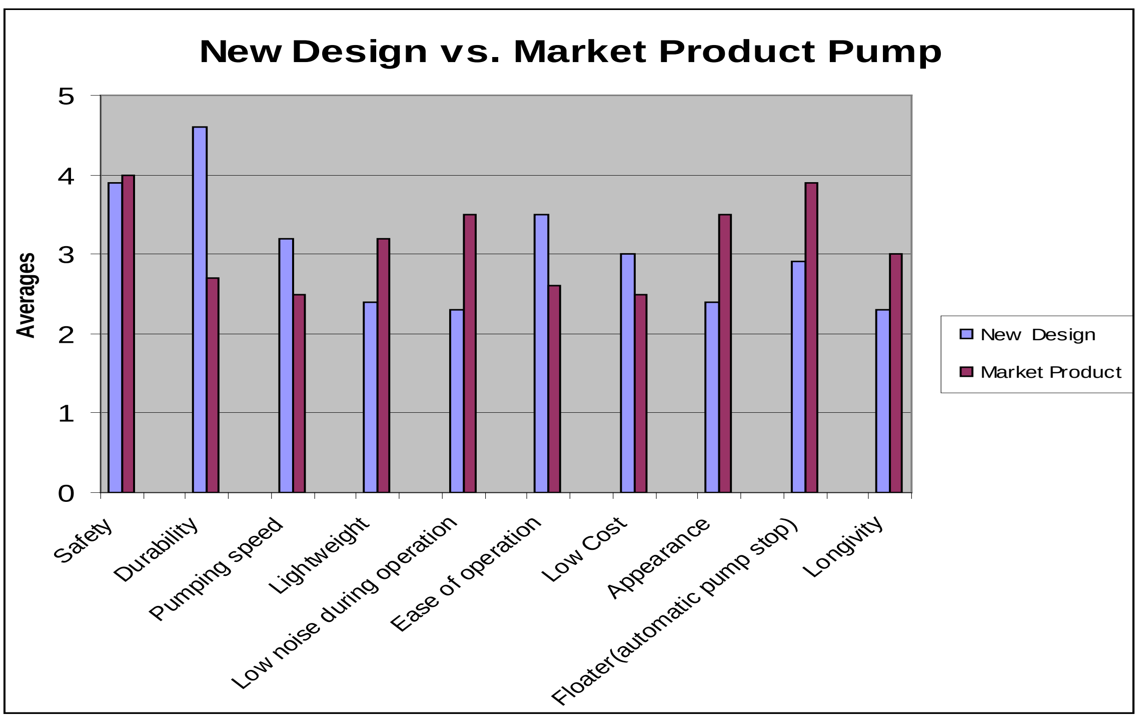
Figure 5 – Pump Diagram

SURVEY AND RESULTS

A survey located in Appendix B was conducted to evaluate customer concerns and needs for this design. Ten surveys were issued for this design. From the results achieved from these surveys, relative importance was established for each design topic and compared to relative satisfaction of the market pumps. The survey was ranked on a five point scale 5-being the most important feature to the customer and 1-being the least important to the customer. This survey was conducted on the planned prototype design and the pumps currently on the market. According to the customer results, durability, safety, and pump speed are among the most important features that the customers care about.

A QFD was also completed to further aid in selection of final design criteria and objectives (Appendix C). Survey data and additional input was used to rate the customer requirements in order of importance relating to the ranking scale of the survey. From the QFD, the planned pump design rating was based exceeding customer importance ratings. These factors were combined and the relative weight of each customer requirement is obtained. The customer requirements have to be achieved by meeting certain engineering criteria. The matrix in the QFD relates the customer requirements to the engineering criteria. Based on this matrix and the relative weight, the absolute importance and relative importance of each engineering criteria was obtained. It was determined that in this design, highest priority should be given to a multi-purpose design and design configuration followed by component quality and material selection. These criteria will allow the prototype to meet the highest rated requirements.

TABLE 1 – DESIGN COMPARISON



Design Concepts

Concept #1

Concept one incorporates a wiper blade device that is attached to the shaft of the motor extended from the impeller. It acts as a device that prevents debris and dirt from entering into the pump system. As the Impeller spins within the pump mechanism, the wiper will also spin on the outside surface of the pump filter in order to prevent debris from entering the system while the pumps inlet is removing the water.
A pump wiper blade within the pump mechanism helps protect the pump from getting clogged with debris or any other unwanted objects. A disadvantage of this system would be that in a situation were heavy objects such as tree limbs or a hard substance would get close to the blade, it could possibly damage the blade and the motor.

Concept #2

Concept two is a design within the pump rather than on the exterior surface of the filter. The design's primary focus area will be between the inlet and the outlet of the pump system. As the impeller is removing the water there will be an interior float that will signal the pump if the filter is clogged and then a reversible valve will be activated drawing either an air supply or water supply in so that pressure will be exerted back through the inlet area to remove the debris from the filter.
Advantages of this design include a virtually maintenance free system that doesn't rely on any mechanical moving parts except for the valve. Also everything will be automatic with little or no human intervention.
Disadvantage of this is that its complexity will prolong the cycle time of the pump due to the stop and run of the system, and if any malfunctions occur in the pump, repair will be difficult.

Concept #3

Concept three's design is similar to concept one in the sense that it operates out of the interior pump and focuses on the filter of the exterior, and also uses the pressurized system that concept two incorporates. This design has a small compressor located on the exterior of the pump frame which exerts a high pressure water spray that is located outside of the filter which prevents debris from clogging the filter.
Advantages of this design are that there no mechanical moving parts and all the components are located on the exterior pump for easy maintenance and repair.
Disadvantages of this design are that the pump will not operate at its maximum efficiency due to the water pressure making it difficult for the water to run smoothly through the system.

Design Section

A weighted decision matrix was developed for all three design concepts to help determine which concept is the best for the pump design. The design factors developed in the QFD were used for the decision matrix from safety to longevity.

Weighted Decision Matrix

Pump Design 1.0

Safety	Durability	Pump Speed	Lightweight	Low Noise	Ease of Operation	Cost	Apperarace	Floater	Longivity
0.07	0.16	0.12	0.06	0.07	0.08	0.19	0.09	0.05	0.10

TABLE 2 – WEIGHTED DECISION MATRIX

For every design factor a weight factor was developed to determine how important it was to the design. Durability and cost were ranked among the highest from customer feedback. Then we would determine the magnitude of the design factor which would rank the score of the design factor and determine if the design ratings would be high or low. For every design concept the design ratings would be added up and the highest ratings is the best concept.

Proof of Design

The following is a list of product objectives of the "Un-Cloggable Pump". The accomplishment of these objectives will guide and prove the design intent when it is completed.

1. Safety
    - Prototype will incorporate a design with no sharp edges or harmful exterior objects.
    - All electrical components will be safely secured to insure no electrical problems
    - Pump will meet submersible pumps code of safety

2. Durability
    - Prototype frame will be made out of a corrosion resistant polypropylene frame, which will be strong and durable.
    - Pump motor will be purchased from a high quality supplier to insure a long cycle life.
    - Filter will be made out of polypropylene and stainless steel material to insure no deformation or corrosion.

3. Pump Speed
    - The prototype will incorporate a pump that will operate at maximum efficiency and remove the fluid at a constant speed.
    - Pump speed will operate at a 3/4hp motor and be able to remove 3300GPH.

4. Lightweight
    - The prototype will be made out of polypropylene and stainless steel material to insure light weight and easy of portability.

5. Ease of Operation
    - Operation of the pump will be a plug and play system so that a user plugs in the pump, and it automatically starts working relative to the floater.

6. Maintenance
    - Standard off-the-shelf components will be used for ease of replacement.
    - Motor will be lubricated so that the motor will not overheat or damage.
    - Design will be simple enough for the user to maintain.

7. Cost
    - The pump will have a target cost price of $300.
    - DFA and DFM techniques will be applied to reduce cost.
    - Standard off-the-shelf pump components will be used to reduce manufacturing costs.

8. Appearance
    - Pump will have a modern appearance with corrosion resistance parts.
    - Materials will be same finish and color for unity of aesthetics.

9. Portability
    - The pump will be able to connect to a three prong grounded outlet.
    - Pump will have a 18ft long cord for versatility
    - Lightweight

10. Floater
    - The prototype will have an automatic stop.

Calculations

Pump Specifications				
Motor	120 V, 60 Hz, 7 Amp		Pump Head	26.61 ft
Power Cord	18 Ft. - 3 Prong Plug		Pump Speed	1425 / 1725 rpm
Dishcarge Size	1/2" - 1 1/2"		Pump Efficiency	85%
Dishcarge Fittings	1-1/2", 1-1/4" and 1"		Blade Torque	27.4 in-lbs
Deleivry Height	26.6 Ft.		Flow Rate	3300 GPH
Maximum Partical Size	1"		Horsepower	3/4 HP
Minmum Water Level	4"		Pump Weight	10.4 lb
Operating Temperature	95°F			
Minum Switch Level	3"			
Dimensions	6" Dia. x 13-1/2" H			
Housing Material	PolyPropalyene Plastic			
Motor Drive	Magnetic Drive			

TABLE 3 – PUMP SPECIFICATIONS

Many of the calculations developed for the new pump design were used to determine which pump should be purchased for this project. To determine the purchased pump the area and conditions that the pump was going to be used in had to be specified. The pump is to be used for residential use such as a pool, pond, or wet basement. The deepest residential pool is usually 10ft deep so the depth of the submersible pump was Debrief Interview Form built around that. Also the flow rate of the pump was determined to be around 3000GPH. The pump chosen for this design operated at up to 18ft deep operating at 3300GPH.

Determining the pump needed was also developed from the pump performance curve shown in Table 4. This helps shows the amount of water pumping out of the system. This compared the flow rate of the pump compared with pump head.

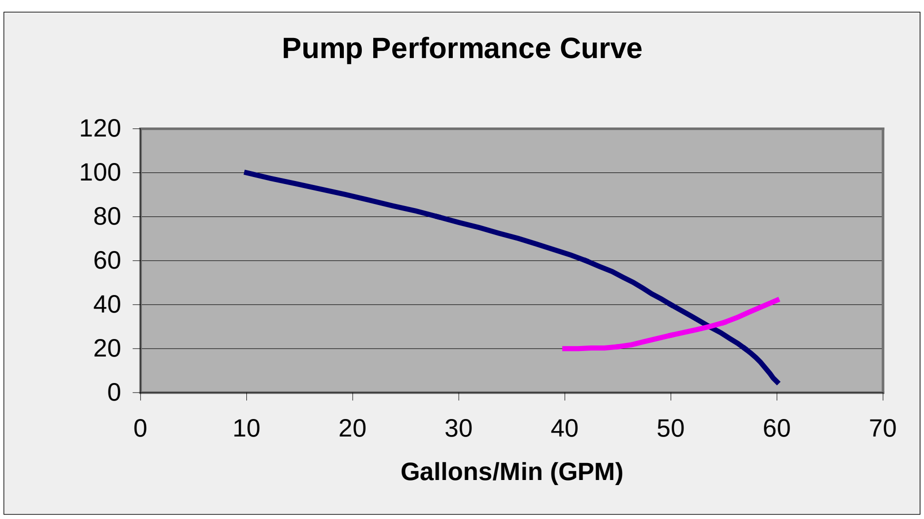


TABLE 4- PUMP PERFORMANCE CURVE

Bill of Materials

Chicago EPT	**94946**	3/4hp Submersible Pump
McMaster	**8716k192**	Polyurethane
McMaster	**6412K41**	Shaft Couplings
McMaster	**7405K5**	Shaft
McMaster	**9358T251**	Stainless Steel Mesh

TABLE 5 - BOM

The main component for the bill of materials was the Submersible Pump and the rest were materials needed for the pump design to be modified into the new design.

Final Design

The final design product has the following features:

- Combined high performance pump and self-cleaning filter
  - Compact and easy to handle
  - Greatly extends pump's operational capability
  - Replaces larger, more expensive pumps
- Filter self-cleans continuously
  - No downtime to clean or replace filters
  - Reduced risk of filter blockage
  - No flow-rate reduction due to partial blockages
- Filter provides more efficient pre-filtration than coarse strainers
  - Improved pump protection
  - Reduces contamination of the impeller
- More cost-effective than other self-cleaning filter systems
  - Lower capital cost
  - Only one moving part, operating on outside of filter.

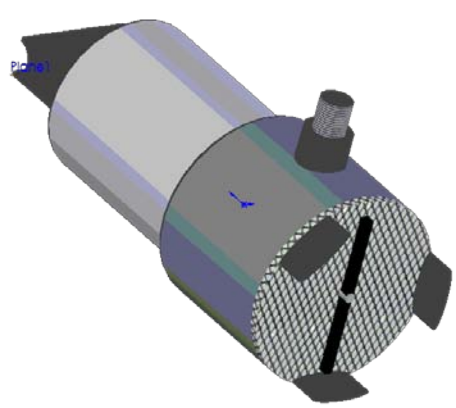


Figure 6 –Pump Drawing

Fabrication and Assembly

Manufacturing of Components

-Wiper blade was constructed using steel sides with a rubber insert that will be able to be removed and changed if needed.

-Filter inlet was manufactured using 6061 Aluminum using a drill press to create the inlet holes.

-The motor shaft used was a hex style design in order to spin the impeller while the shaft is spinning

Assembly shown in Figures 7-10

Figure 7: Impeller with Extended Shaft

Figure 8: Suction Inlet Grid

Figure 9: Wiper Blade Device

Figure 10: Wiper Device Connected

Testing (methods and results)

After the building process of the pump design the testing of the pump design was the next step. As the table shows below two pumps that were at the same specifications running at 3300GPH were tested in debris filled water. One pump had no modifications with a regular filter and the other incorporated the new design. They were both tested to remove 300 gallons of water and was tested to determine which pump operated at a faster pace.

Testing Results

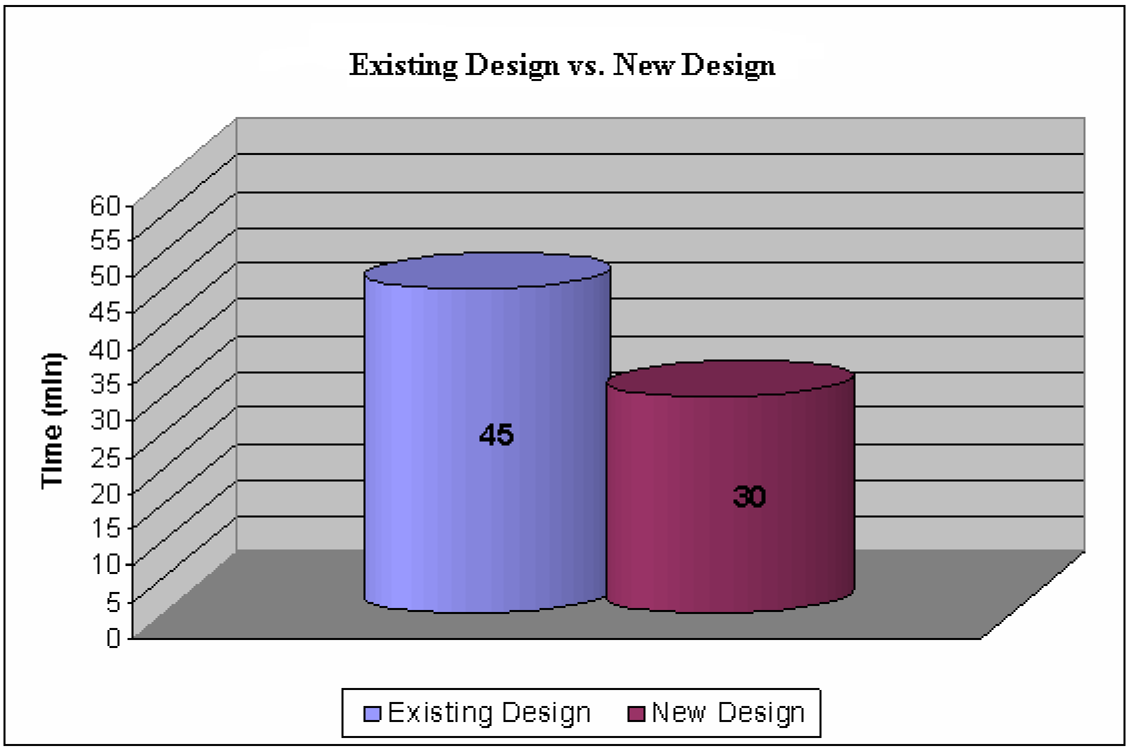


Table 6

This graph show the amount of time it took to pump out 300 gallons of debris filled water.

SCHEDULE AND BUDGET

. The schedule is located in Appendix D is based on the dates surrounding the project that are most important. During the first phase of the schedule, many of the main topics are focused on the proof of design, weighted decision matrix, and the design of the prototype. The deadline of the report is the middle point on the schedule which splits the design process from the building process. The second phase of the schedule mainly focuses on the building process of the prototype, including assembly and construction of the design. The major dates for this schedule are mainly the deadline dates, on March 14th the design report is due which incorporates everything from the beginning of the project leading until the end. The main two deadlines to consider is the Tech Expo May 17th and the project report presentations June 6th. This leads to the end of the schedule, which incorporates the final design leading into the Tech expo.

The preliminary budget was developed mainly according to the off-the-shelf components available for the current pumps. There will also be minimal manufacturing costs affiliated with the pump design. The estimated amount for this design is set at $420; this includes all purchased parts, material, and labor. The preliminary budget can be found in Appendix E. When the project is completed, the actual budge will be compared to the preliminary budget and should be with in 20% of that value.

Conclusion and Recommendations

- Create a thinner wiper blade in order to reduce the turbulence of the inlet
- A filter in which the bolts are not on the exterior so that the wiper blade can spin from edge to edge
- Possibly patent the design

Figure 11- Final Assembly

REFERENCES

[1] Source: American Water Works Association. 1996. *Water Transmission and Distribution: Principles and Practices of Water Supply Operations*, 2nd edition. Denver, CO: 10/02/06
Available HTTP: www.nesc.wvu.edu/.../OT/SU03/TB_SU03.html

[2] Submersible Trash Pumps 10/02/06
Available HTTP: http://www.pumps-in-stock.com/submersible_trash_pumps.html

[3] Leo Products (Online Products Page) 10/02/06
Available HTTP:www.pumps-china.com/garden_submersible_pumps.htm

[4] Alita Submersible Pumps (Online Products Page) 10/02/06
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[5] Wikipedia (Online Encyclopedia)
Available HTTP: http://en.wikipedia.org/wiki/Pump

APPENDIX A – EXISTING PRODUCTS

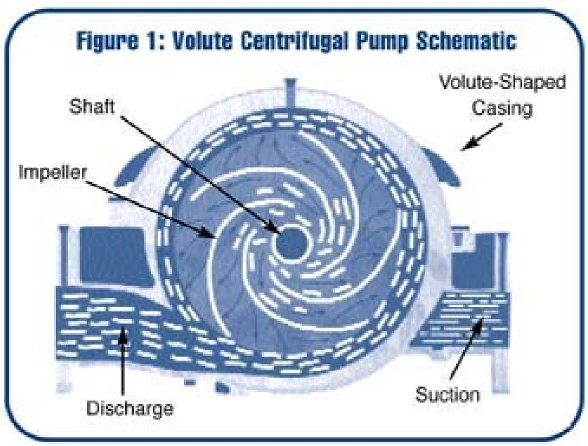
Shteiwrn

Problem Statement: The problem with the modern day water pumps is the once they get clogged with debris the pump will slowly stop pumping the water out of the desired area and the effectiveness of the pump is lost. A pump that will help prevent the debris from getting clogged will be ideal for water pump applications.

Electronic Research Documentation

www.nesc.wvu.edu/.../OT/SU03/TB_SU03.html 10/02/06

Source: American Water Works Association. 1996. *Water Transmission and Distribution: Principles and Practices of Water Supply Operations*, 2nd edition. Denver, CO:



Parts of a Pump
Important Terms of a Pump

Glossary of Pump Terms

Head—(1) A measure of the energy possessed by water at a given location in the water system expressed in feet; (2) a measure of the pressure or force exerted by water expressed in feet.
Velocity Head—A measurement of the amount of energy in water due to its velocity or motion.
Pressure Head—A measurement of the amount of energy in water due to water pressure.
Impeller—The moving element in a pump that drives the fluid.
Efficiency—A ratio of total energy output to the total energy input expressed as a percent.
Priming—The action of starting the flow in a pump or siphon. With a centrifugal pump, this involves filling the pump casing and suction pipe with water.

WWW.PONDPALS.COM/POND_PUMPS/ALITA_SUBMERSIBLE. 10/02/06 **ALITA SUBMERSIBLE PUMPS**

ALITA Submersible Pumps

Constructed with stainless steel and engineering composites with glass fiber reinforcement, Alita submersible pumps are both lightweight and corrosion resistant.

With seal components utilizing high precision Silicon Carbide mechanical shaft seals with surface approaching the hardness of diamond, every model of Alita pumps are capable of operation under corrosive and abrasive conditions.

SKU	Description	Price	Order
ALT200	Alita 200 Submersible Pump	out of stock	Buy Now
ALT250	Alita 250 Submersible Pump	254.95	Buy Now
ALT400	Alita 400 Submersible Pump	299.95	Buy Now

Pump Model	ALT-200	ALT-250	ALT-400
Voltage, Frequency, Phase	100V - 120V AC, 60Hz, Single Phase		
Discharge (FNPT)	2 in	2 in	2 in
Outlet Adapter (MNPT x Insert)	1.5 in, 2 in	2 in	2 in
Motor Output Rating	1/4 HP	1/3 HP	1/2 HP
Maximum Head	20 ft	23 ft	26 ft
Maximum Capacity (110V, 60Hz)	2900 gph	3800 gph	4400 gph
Maximum Solid Passage	1.10 in	1.38 in	1.4 in
Physical Dimension	9.5" x 14.6"	9.5" x 15.4"	9.5" x 15"
Weight	11.5 lb	13.7 lb	18 lb
Power Cable	20 ft	20 ft	20 ft

Lightweight
Corrosion resistant
1/4-1/2hp
Submersible

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www.pumps-china.com/garden_submersible_pumps.htm 10/02/06 **Leo Products**

GARDEN PUMP

We are professional submersible pumps, garden submersible pumps manufacturer and factory in China. We can produce submersible pumps, garden submersible pumps according to your requirements. More types of submersible pumps, garden submersible pumps wanted, please contact us right now!

KS-401PW

Model	XKS-401PW	XKS-551PW	XKS-751PW
Supply Power	220-240V/50HZ	220-240V/50HZ	220-240V/50HZ
Input Power	400W	550W	750W
Max Head	6m	6m	8m
Max Flow	9m^3/h	12m^3/h	13.5m^3/h
Max dia.of particle	30mm	35mm	35mm
Outlet	25/32mm	25/32mm	25/32mm
Cable	H05RN-F 10m	H05RN-F 10m	H07RN-F 10m

X

Garden Pumps
Input Power
Max Head
Max Flow
Outlet
Floater Stop
Submersible Pumps

Model	XKS-402PW	XKS-552PW	XKS-752PW
Supply Power	220-240V/50HZ	220-240V/50HZ	220-240V/50HZ
Input Power	400W	550W	750W
Max Head	6m	6m	8m
Max Flow	9m^3/h	12m^3/h	13.5m^3/h
Max dia.of particle	30mm	35mm	35mm
Outlet	25/32mm	25/32mm	25/32mm
Cable	H05RN-F 10m	H05RN-F 10m	H07RN-F 10m

Model	XKS-401PSW	XKS-551PSW	XKS-751PSW
Supply Power	220-240V/50HZ	220-240V/50HZ	220-240V/50HZ
Input Power	400W	550W	750W
Max Head	6m	7m	9m
Max Flow	9m3/h	11m3/h	12m3/h
Max dia.of parti	30mm	35mm	35mm
Out			

http://www.pumps-in-stock.com/submersible_trash_pumps.html 10/02/06 Submersible Trash Pumps

Dimensions: 12.9375" Height x 10 1/6'

2", 53 GPM, 1/2 HP, 115V, Contractor grade submersible trash pump.
Pumps sand, solids and debris with minimal wear and clogging.
Optional float switch for automatic operation.
*** click here for more detailed info ***

$ 249

2"
53 GPM
What is this?
1/2 HP (0.37 kw)

25 lbs
3/8" max solids
39 ft max head
max head,
What is this?

full spec

Quantity 1 at **$249** each

Accessories

Free Shipping In stock - can ship tomorrow (Mon - Fri)

Multiquip ST2040T electric submersible trash pump

Dimensions: 17" Height x 10 1/3" Diameter

2", 83 GPM, 1/2 HP, 115V, Contractor grade submersible trash pump.
Cast iron pump casing for the demanding environments encountered with heavily debris-laden water.
Equipped with a 2" discharge port that can easily handle solids up to 1 inch in diameter. A vortex action discharges solids away from the multi-vane impeller.
*** click here for more detailed info ***

$ 345

2"
83 GPM
What is this?
1/2 HP (0.37 kw)

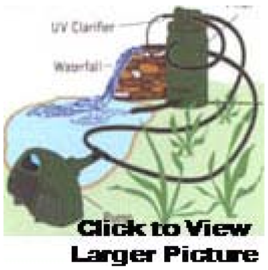
57 lbs
1" max solids
40 ft max head
max head,
What is this?

foryourfish.com/cgi-bin/webc.cgi/tetra.htm

TetraPond OFX Open-Flow Debris-Handling Pump

Clean Your Pond, Not Your Pump!

The new *TetraPond OFX Open-Flow Debris-Handling Pump* is specifically designed to clean the pond as it pumps. The *OFX Pump* sends debris-laden water to an external filter without clogging. The innovative cage design allows debris up to 3/8" to pass through the perforated shell to a specialized rugged impeller, which forces the debris to the ponds' external filter where it is easily removed. No messing with pre-filters, just put the OFX in you pond and let it do its job-cleanly and efficiently. Protected by a three year warranty.



TetraPond OFX Pump Features:

* Resists Blockage, virtually eliminating pump maintenance - no more cleaning of pre-filters
* Sends Solids up to 3/8" to external filter for removal
* Powers External Filters, Waterfalls, and Streams
* Energy Efficient, 20' electrical cord
* Oil-Free - will not contaminate aquatic life.

APPENDIX B – SURVEY AND RESULTS

Smart Holes Pump

Customer Survey

I am a senior at the University of Cincinnati studying Mechanical Engineering Technology. I am looking to improve the current pump design in order to pump water out of desired area even if its filled with debris. Please take a few minutes to answer the following questions to help us better our design.

What is important to you for the design of the improved pump? Please circle the appropriate answer. 1 = low importance 5 = high importance

			R		R		R		R		R		Averages
1	Safety	1	0	2	0	3	3	4	5	5	2	39	**3.9**
2	Durability	1	0	2	0	3	1	4	2	5	7	46	**4.6**
3	Pumping speed	1	1	2	1	3	5	4	1	5	2	32	**3.2**
4	Lightweight	1	1	2	4	3	5	4	0	5	0	24	**2.4**
5	Low noise during operation	1	3	2	3	3	2	4	2	5	0	23	**2.3**
6	Ease of operation	1	0	2	1	3	5	4	2	5	2	35	**3.5**
7	Low Cost	1	0	2	2	3	6	4	2	5	0	30	**3**
8	Appearance	1	2	2	3	3	4	4	1	5	0	24	**2.4**
9	Floater(automatic pump stop)	1	1	2	3	3	3	4	2	5	1	29	**2.9**
10	Longivity	1	3	2	2	3	4	4	1	5	0	23	**2.3**

Are you satisfied with the current pumps on the market? Please circle the appropriate answer. 1 = very unsatisfied 5 = very satisfied

			R		R		R		R		R		Averages
1	Safety	1	0	2	0	3	2	4	6	5	2	40	**4**
2	Durability	1	1	2	3	3	4	4	2	5	0	27	**2.7**
3	Pumping speed	1	2	2	2	3	5	4	1	5	0	25	**2.5**
4	Lightweight	1	1	2	0	3	6	4	2	5	1	32	**3.2**
5	Low noise during operation	1	0	2	3	3	2	4	2	5	3	35	**3.5**
6	Ease of operation	1	1	2	2	3	7	4	0	5	0	26	**2.6**
7	Low Cost	1	2	2	2	3	5	4	1	5	0	25	**2.5**
8	Appearance	1	0	2	1	3	5	4	2	5	2	35	**3.5**
9	Floater(automatic pump stop)	1	0	2	0	3	3	4	5	5	2	39	**3.9**
10	Longivity	1	1	2	1	3	6	4	1	5	1	30	**3**

For future reference design please list any other important features that you would like

How much would you be willing to pay for this design? $50-$100, $100-$200, $200-$500

$500-$1000, $1000-$2000

R Results of numbers tallyed for the design

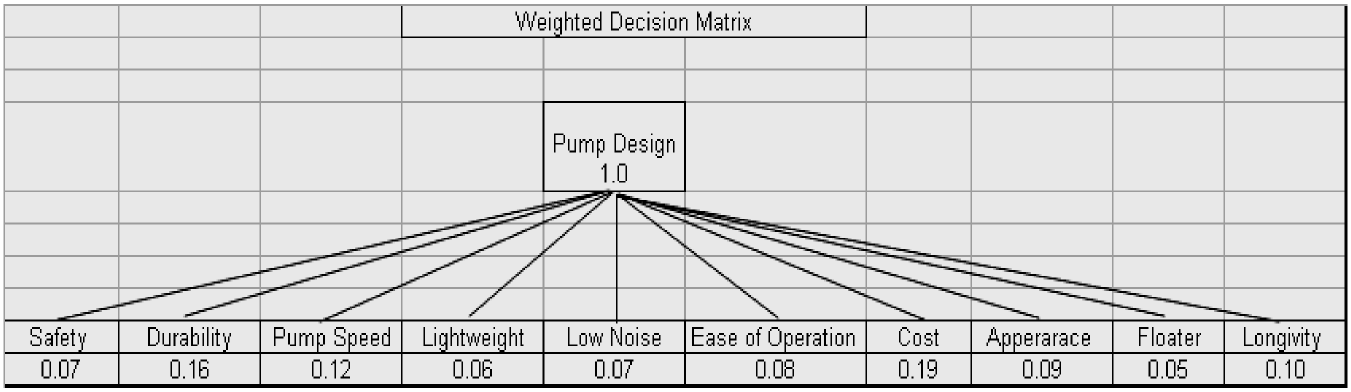
Thank you very much for completing this survey, your comments will be very helpful to the design team.

APPENDIX C – QFD DIAGRAM AND RESULTS

9 = Strong
3 = Moderate
1 = Weak
no relation = blank

	Material Selection	Back-up Devices	Corrosion Resistance	Wear Component Quality/Life	Modern Equipment Selection	Off-the-shelf Components	Modular Design	Multi-purpose Design	Design Configuration	Customer importance for newdesign	Satisfaction with current pumps	Planned pump design	Improvement ratio	Sales points	Improvement (Absolute weight) ratio	Relative weight
1. Safety	3	9		3						3.90	4.00	3.5	0.88	1	3.41	0.07
2. Durability	3		9	9					1	4.60	2.70	4.5	1.67	1	7.67	0.16
3. Pump Speed	9				9	3				3.20	2.50	3.5	1.40	1.3	5.82	0.12
4. Lightweight	9					3				2.40	3.20	4	1.25	1.0	3	0.06
5. Low noise	9				3	3	3			2.30	3.50	4	1.14	1.3	3.42	0.07
6. Ease of operation		3					3		9	3.50	2.60	3	1.15	1	4.04	0.08
7. Cost	9					3	3			3.00	2.50	5	2.00	1.5	9	0.19
8. Apperance			3		3		3			2.40	3.50	4	1.14	1.5	4.11	0.09
9. Floater	9									2.90	3.90	3	0.77	1.0	2.23	0.05
10. Longivity	3		3						3	2.30	3.00	5	1.67	1.3	4.98	0.1
Absolute Importance	5.44	0.90	2.02	1.66	1.57	1.34	1.29	0.00	1.24	15.46					47.7	1.00
Relative importance	0.35	0.06	0.13	0.11	0.10	0.09	0.08	0.00	0.08							
Pump now on market																
Direction of movement	x	x	x	x	x	x	x	x	x							
Target Value																
Units																

APPENDIX D – WEIGHTED DECISION MATRIX



	Weight Factor	Units	Concept #1 (Wiper)			Concept #2 (Interior)			Concept #3 (Pressure)		
			Magnitude	Score	Rating	Magnitude	Score	Rating	Magnitude	Score	Rating
Safety	0.07	Experience	Good	3	0.21	Good	3	0.21	Good	3	0.21
Durability	0.16	Experience	Good	3	0.48	Low	1	0.16	Low	1	0.16
Pump Speed	0.12	GPH	Good	3	0.37	Low	1	0.12	Low	1	0.12
Lightweight	0.06	Experience	Good	3	0.19	Good	3	0.19	Good	3	0.19
Low Noise	0.07	Experience	Good	3	0.21	High	5	0.36	Low	1	0.07
Ease of Operation	0.08	Experience	High	5	0.42	Low	1	0.08	Good	3	0.25
Cost	0.19	Dollars	Good	3	0.57	Low	1	0.19	Good	3	0.57
Apperanace	0.09	Experience	Good	3	0.26	High	5	0.43	Low	1	0.09
Floater	0.05	Experience	Good	3	0.14	Good	3	0.14	Good	3	0.14
Longivity	0.10	Experience	Good	3	0.31	Good	3	0.31	Good	3	0.31
Total	**1.00**				**3.17**			**2.20**			**2.12**
5 Point Scale	High - 5	Good - 3	Low - 1								

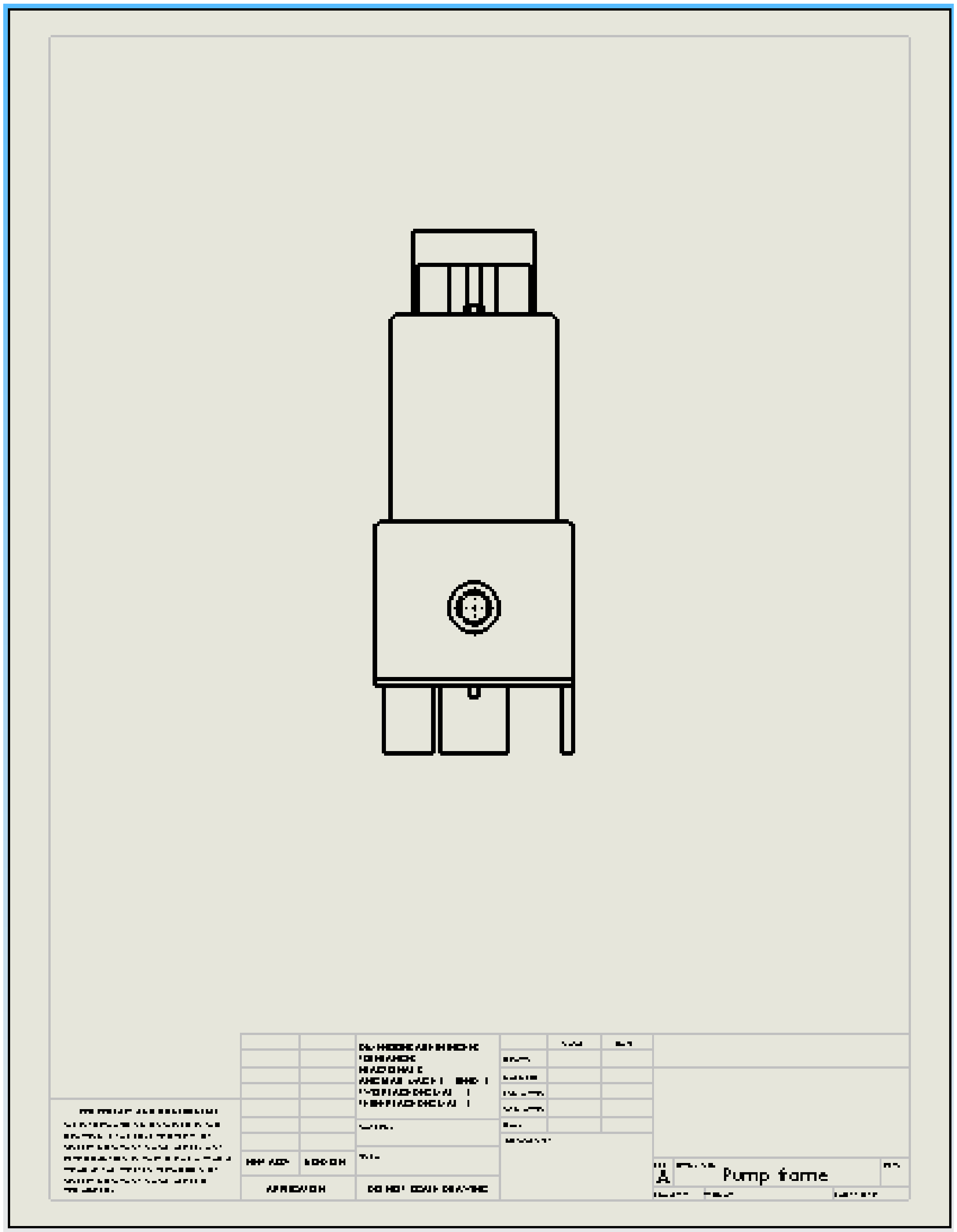
APPENDIX-E – CALCULATIONS

Pump Calculation Data				
Motor	120 V, 60 Hz, 7 Amp		Pump Head	26.61 ft
Power Cord	18 Ft. - 3 Prong Plug		Pump Speed	1425 / 1725 rpm
Dishcarge Size	1/2" - 1 1/2"		Pump Efficiency	85%
Dishcarge Fittings	1-1/2", 1-1/4" and 1"		Blade Torque	27.4 in-lbs
Deleivry Height	26.6 Ft.		Flow Rate	3300 GPH
Maximum Partical Size	1"		Horsepower	3/4 HP
Minmum Water Level	4"		Pump Weight	10.4 lb
Operating Temperature	95°F			
Minum Switch Level	3"		BLADE SPEED	65 RPM
Dimensions	6" Dia. x 13-1/2" H			
Housing Material	PolyPropalyene Plastic			
Motor Drive	Magnetic Drive			

APPENDIX – F – BILL OF MATERIALS

BILL OF MATERIALS				
Part Number	Manufacturer	Part Number	Description	Quantity
1	Chicago EPT	94946	Float Switch	1
2	Chicago EPT	-	Power cable & plug	1
3	Chicago EPT	-	Nut	2
4	Chicago EPT	-	Plastic handle	1
5	Chicago EPT	-	Washer	3
6	Chicago EPT	-	Screw	3
7	Chicago EPT	-	Outer pump housing	1
8	Chicago EPT	-	Screw	1
9	Chicago EPT	-	O-ring	2
10	Chicago EPT	-	Rear housing motor	2
11	Chicago EPT	-	Cord Jacket	1
12	Chicago EPT	-	Cord clip	1
13	Chicago EPT	-	Cord clip	1
14	Chicago EPT	-	Screw	1
15	Chicago EPT	-	Condenser	2
16	Chicago EPT	-	Base cover	1
17	Chicago EPT	-	Base	1
18	Chicago EPT	-	Screw	3
19	Chicago EPT	-	Nut	1
20	Chicago EPT	-	Impeller	1
21	Chicago EPT	-	Adjustable washer	1
22	Chicago EPT	-	Seal washer	1
23	Chicago EPT	-	Locating ring	1
24	Chicago EPT	-	Screw	6
25	Chicago EPT	-	Press ring	1
26	Chicago EPT	-	O-ring	1
27	Chicago EPT	-	Skeleton seal	3
28	Chicago EPT	-	Front cover	1
29	Chicago EPT	-	Front bushing	1
30	Chicago EPT	-	Bearing	1
31	Chicago EPT	-	Rotor	1
32	Chicago EPT	-	Under washer	2
33	Chicago EPT	-	Stator	1
34	Chicago EPT	-	Spring washer	1
35	Chicago EPT	-	Screw	1
36	Chicago EPT	-	Earthing wire	1
37	Chicago EPT	-	Rear cover	1
38	Chicago EPT	-	Washer	1
39	Chicago EPT	-	Valve bush	1
40	Chicago EPT	-	Ball	1
41	Chicago EPT	-	O-ring	1
42	Chicago EPT	-	Nut	1
43	Chicago EPT	-	O-ring	8
44	Chicago EPT	-	Washer	6
45	Chicago EPT	-	Screw	5
46	Chicago EPT	94946	Universal Adapter	1
47	McMaster	8716k192	Polyurethane	1
48	McMaster	6412K41	Shaft Couplings	2
49	McMaster	7405K5	Shaft	1
50	McMaster	9358T251	Stainless Steel Mesh	1

APPENDIX – G – SOLIDWORKS DRAWINGS



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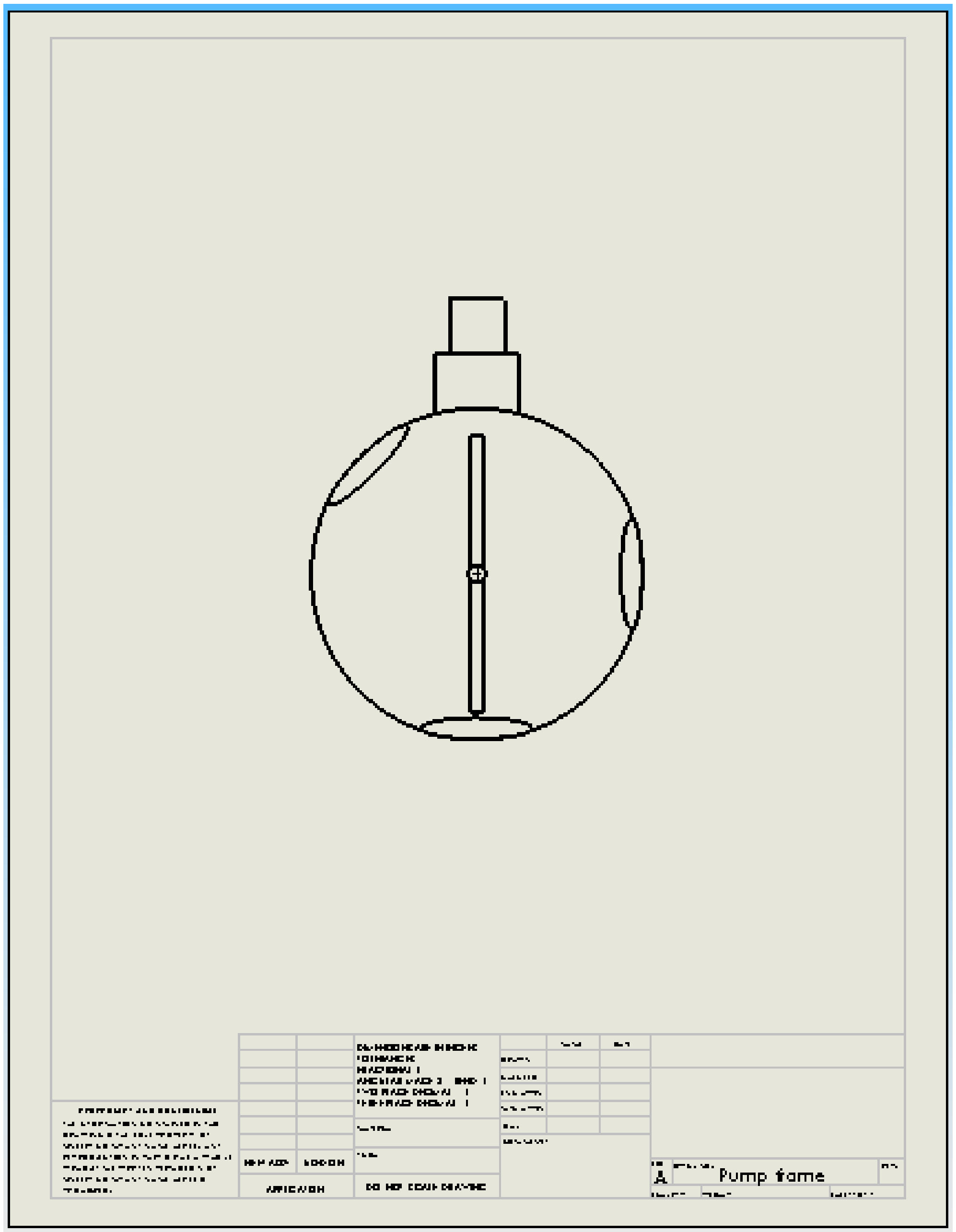

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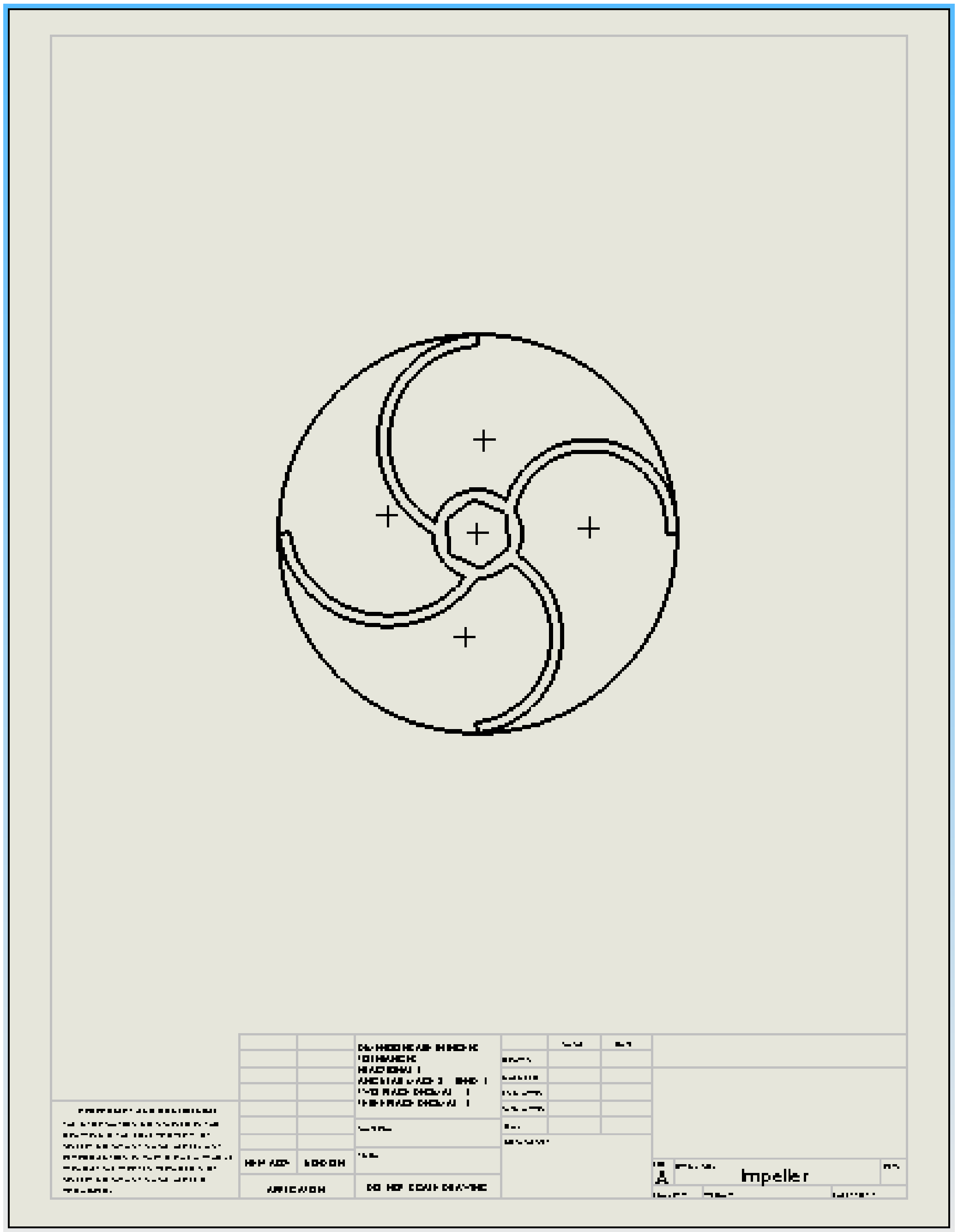

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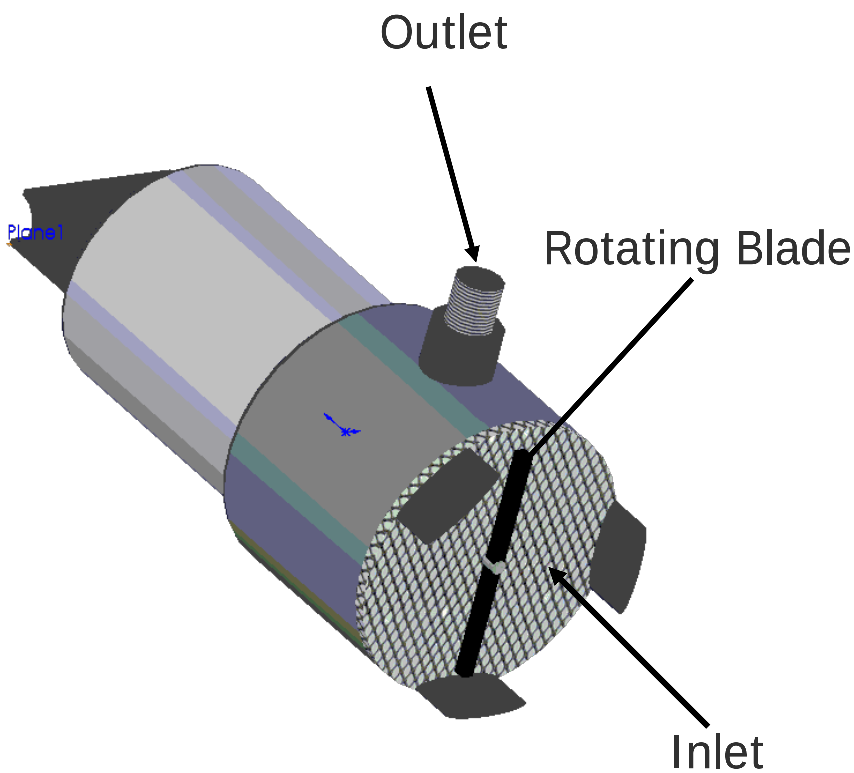

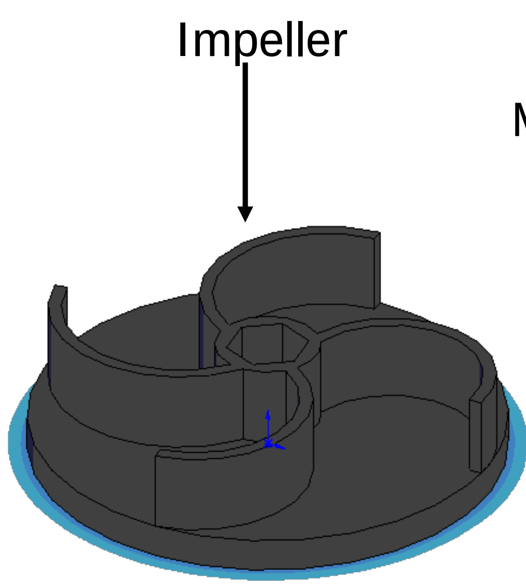

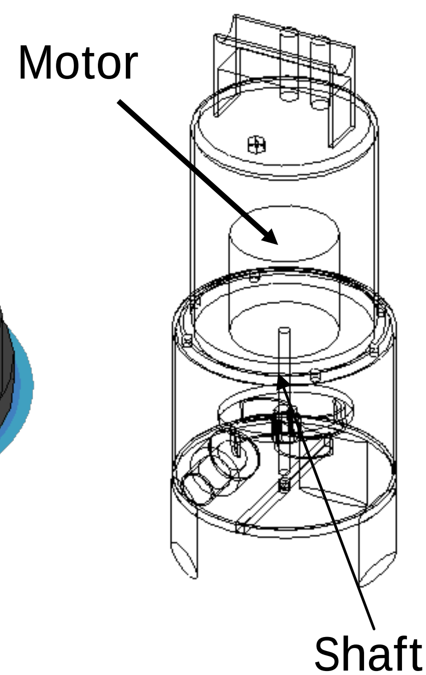

APPENDIX H – SCHEDULE

Raed Shteiwi																							
All Condition Pump	Winter Quarter											Spring Break	Spring Quarter										
Dates	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/3	6/4-6/10
Tasks																							
Proof of design	10-Jan	■																					
Weighted Objective Method		■	■																				
Design of Sheel frame			■	■																			
Design of Interior Shell				■																			
Design of interior pump configuration					■	■																	
Design of electrical housing						■	■																
Design automatic stop							■																
Design Freeze								■															
Oral Design Presentation									■														
Touch up design										■													
Design Report (deadline)											14-Mar												
Spring Break												■											
Build Sheel frame													■	■									
Build Interior Housing														■									
Build electrical housing															■								
Build top frame with Floater housing															■	■							
Connect Interior pump																■	■						
Demonstration																		■					
Correct problems																			■				
Tech EXPO (deadline)																				17-May			
Start Oral Presentation																					■		
Project Report																						■	6-Jun

APPENDIX I –BUDGET

All Condition Pump Budget			
Materials,Components	Forcasted Amount	Materials,Components	Actual Amount
Frame	$100.00	Pump	$74.95
Electronic Plug	$50.00	Polyurethane	$21.30
Switches	$50.00	Shaft Couplings	$40.60
Pump motor	$80.00	Shaft	$18.13
Automatic stop	$75.00	Stainless Steel Mesh	$120.68
Pump inlet plastic	$15.00	MISC (Screws/bults)	$24.00
Misc services/parts	$50.00		
Total	$420.00		$300.00