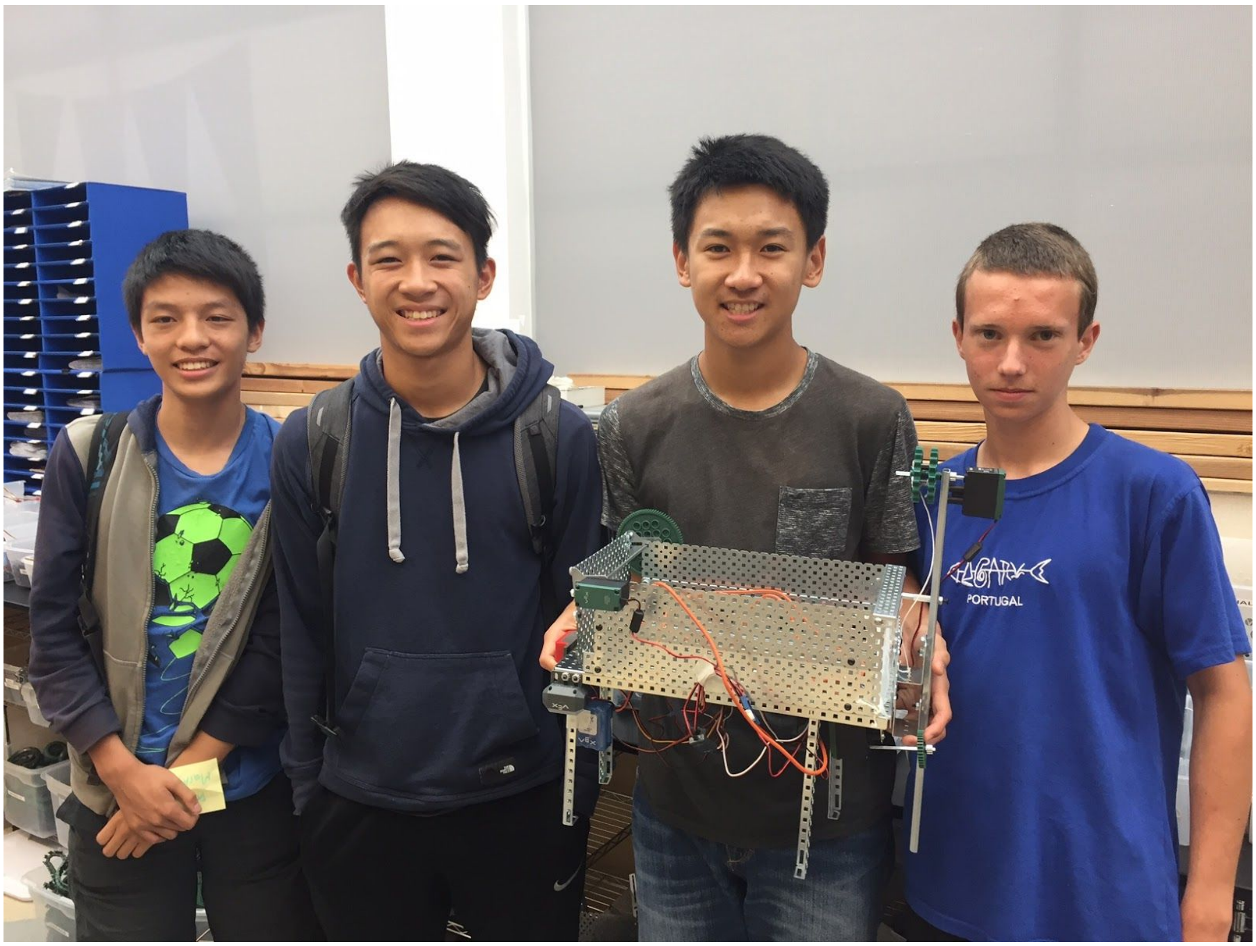
Mark Kong
Loic Scomparin
Jeffrey Tian
Sean Tseng
5/8/17

Sedi-Bot



Principles of Engineering
Period 6
5/5/17-5/22/17

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Brainstorming - Potential Problems

- Problem: scrambled legos solution: Lego sorter? A mini one for households (it would be a type that is more household friendly)

- Problem: crowded buses and other types of public transportation
- Solution: folding / retractable seats to conserve space (not just in the front of the bus for the handicapped, but maybe applicable to subways to increase the amount of riders on one ride)

- Problem: Umbrellas that flip inside out during windy and rainy days

- Problem: Phone batteries don't last long enough

- Problem: Sinks at dublin high are constantly being filled with trash and are being vandalized

- Problem: Inventory gets disorganized/low and needs to be managed Solution: an inventory manager that can either sort objects or tell the user when the items are depleted

- Problem: lawn blowers, lawn blowers are too loud, find a way to make them quieter

- Problem: In California and other areas there has been a continued need to build new reservoirs, which is impactful to the environment. Sedimentation of existing reservoirs causes lack of available water storage and is a waste of existing dams. Sediment also damages turbines that produce hydroelectric power. Currently there is no way to remove sediment in large reservoirs and smaller reservoirs need to be drained completely. Sedimentation is accelerating with global warming.

*the highlighted Problem is the one we are going to address and design a machine to fix

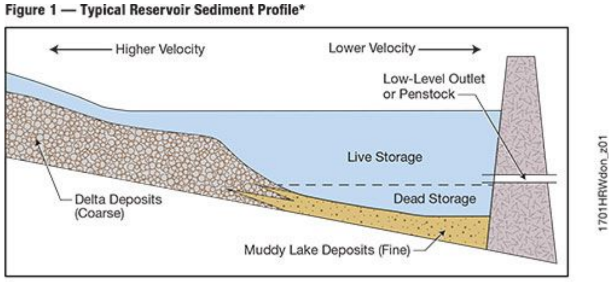
Brainstorm - Sedimentation Solution

- Dual-net system with large mesh first, allows sediment and water to pass through but not fish, plants, floating debris, etc
- Second mesh is finer and traps the sediment
- Attached to solid frame that can lifted and lowered using a robotic arm
- Would essentially remove sediment and dump it outside of reservoirs
- Could add conveyor belt that transports the sediment to a storage container
- Net must be long enough to reach the bottom of the reservoir in order to gather sediment
- A way to measure the amount of sediment on the bottom of the reservoir
- Dump the excess sediment to the rivers downstream in order to replenish the ecosystem

Construction: VEX robotic platform would represent barge

- Robotic arm goes over side of barge and into water, net system is attached to it
  - Would most likely need 2 motors to be able to pull out both fish nets from our pump.
  - The arms will move the nets so that the sediment can be cleaned by other workers
- Drags through the water (barge needs motors)
- Could use switch to operate lifting of the net contraption, or use automatic program to lift net out when too heavy
- Could use a potentiometer attached to the nets in order to measure the weight of the nets and once potentiometer reaches its limit, it pulls the net back to the barge.
- Could also use an ultrasonic sensor to

Figure 1 — Typical Reservoir Sediment Profile*



Typically, sedimentation in the reservoir behind a dam takes the form of progressively finer materials being deposited as the flows approach the dam.
*Adapted from Morris, G.L. and J. Fan, *Reservoir Sedimentation Manual*, McGraw-Hill, New York, 1998.

Problem Description/Design Brief

Clients	National Hydropower Association, PG&E, California Department of Water Resources, EDF France
Designers	Mark Kong, Loic Scomparin, Jeffery Tian, Sean Tseng
Problem Statement	All dams have a certain lifespan before sediment fills the reservoirs they impound and critically diminish water storage. Sedimentation is a major problem both to humans and the environment as more and more dams are built to replace non-functional ones.
Design Statement	Design, build, and test a small-scale prototype of a machine capable of extracting sediment from a reservoir to save water storage.
Constraints	General: ● Prototype must be built in 2 weeks ● Prototype must be built utilizing skills from team members' engineering classes Problem Specific: ● Must have a programmable mechanism capable of lowering into the water and capturing sediment particles ● Must be mounted on a boat or barge that is highly mobile ● Must have a designated area and system for sediment storage ● Must contain a method of propulsion/movement
Deliverables	● Physical prototype (VEX construction) ● Prototype program (RobotC) ● Research Document ● Research Presentation

Research / Prior Solutions

Due to the creation of dams, many reservoirs experience the effect of reservoir sedimentation, a process of erosion where sediment is carried down by running water into reservoirs, where is settles down and fills space, being unable to move downstream. A reservoir's life has 3 stages, including the continuously occurring sediment accumulation, partial sediment balance, and full sediment balance. Partial sediment balance is where fine sediments do not accumulate, but coarse sediments continue to accumulate on the bottom of the reservoir. The last stage, full sediment balance, is when both sizes of sediment do not settle down. Most of the world's reservoirs are currently in the continuous accumulation stage, and each reservoir has an estimated life time based on their volume and sedimentation rates of the river. Eventually, all reservoirs will accumulate enough sediment to be unusable, due to the amount of built up of sediment on the bottom of the reservoir. Less reservoir volume means that there is less water able to be stored for the dry season, less flood control space during the wet season, and increased environmental impact as additional dams have to be built to replace those holding back more and more sediment. Additionally, excess sediment eventually damages dam turbines, which are essential to releasing water downstream and producing electricity for millions of homes around the world. After the collapse of the main spillway at Oroville Dam in California in February 2017, the turbines had to be shut down for two weeks due to sedimentation, preventing the release of water downstream.

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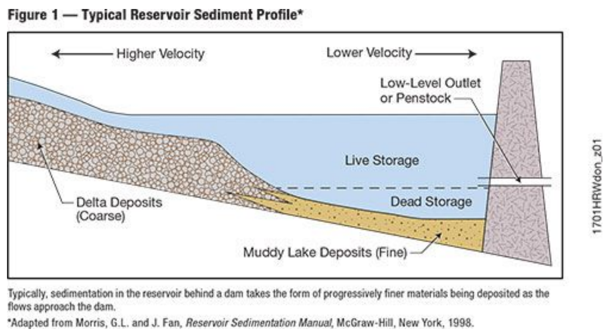
<td>
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<tr>
<td>Typical reservoir sediment storage- note the dead storage space that has to be put aside for sediment.
Retrieved from http://www.hydroworld.com</td>
<td>Buildup of sediment visible in Condit Reservoir, Washington, after the reservoir was drained.
Retrieved from http://www.klamathbasincrisis.org</td>
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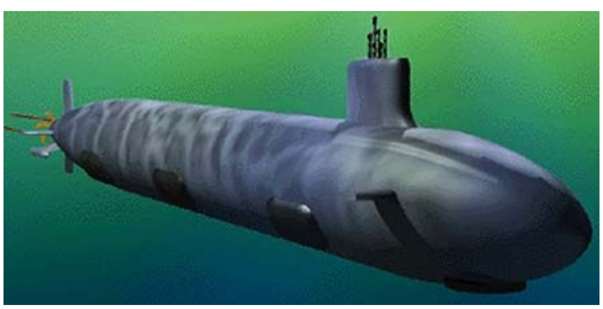
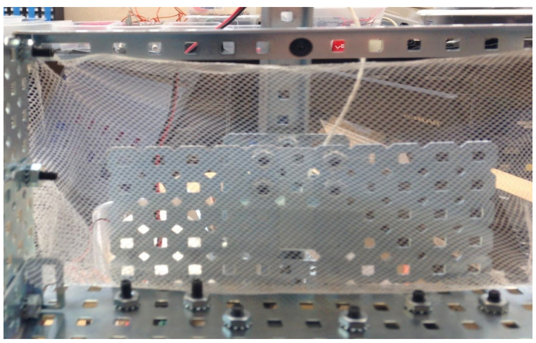
A prior solution to removing sediment includes draining out the entire reservoir and then removing the sediment from the reservoir. For example, the Big Tujunga Reservoir Sediment Removal Project located in Los Angeles plan to remove sediment from their reservoir by emptying the reservoir between April and October, and excavating the sediment using bulldozers and backhoes. Another solution is sediment flushing, a process where accumulated sediments in the reservoir are eroded and swept downstream by the accelerated flow rate of water, which can be released by additional dams upstream. However, larger reservoirs cannot benefit from these techniques due to their size and the fact that they need to hold water all year, so they lose 0.5-2% of their water storage space very year.

Our solution is to build an underwater vehicle that filters out suspended sediment before it settles down and becomes bedded sediment that reduces the usable depth of the reservoir. No prior solutions exist that remove suspended sediments in reservoirs. In order to build an underwater vehicle, the vehicle must be lightweight in order to stay buoyant underwater, but also must withstand the high water pressure without imploding. Metals that can withstand the high water pressure usually contain either titanium or steel. Our robot would be similar to a submarine, so it would consist of two hulls, the outer hull being water proof and the inner hull being much stronger and resistant to water pressure. The inner hull of existing submarines usually contains either steel or titanium, since these metals are strong enough to resist high water pressure. Such a design would be essential to capture sediment in deeper water, where it is often more concentrated.

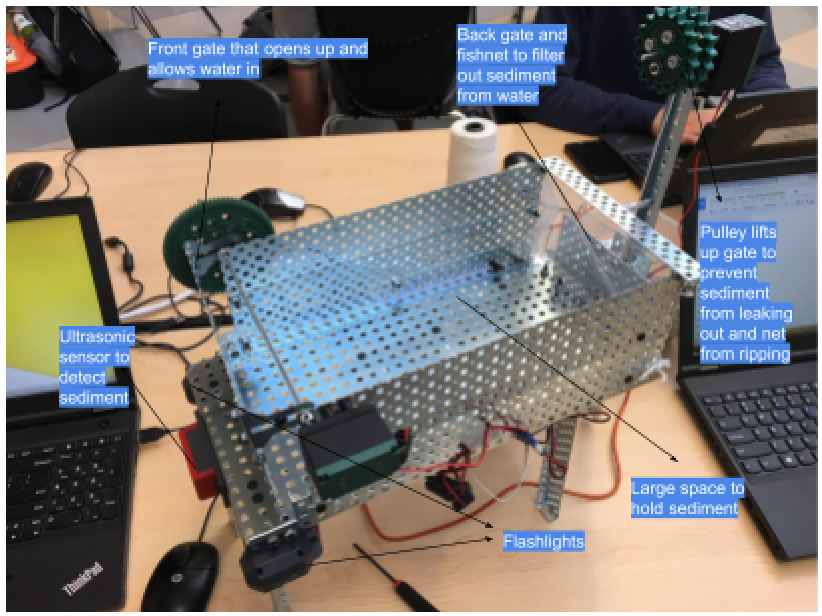
	Bulldozers and other machines are used to remove sediment from the Feather river after the Oroville spillway crisis. This solution is costly and not applicable to deep reservoirs. Retrieved from http://www.mercurynews.com
	United States Navy submarine- although not for the same purpose, it features the same materials that could be used for a sedimentation robot. Retrieved from http://www.keywordsuggests.com

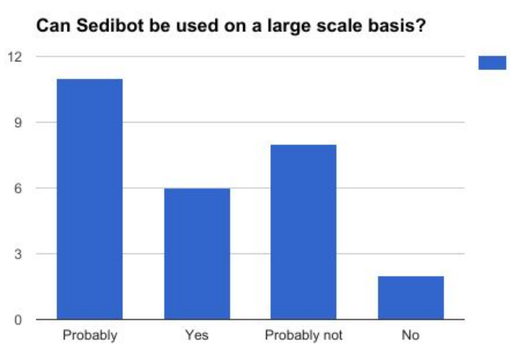
Solution Summary

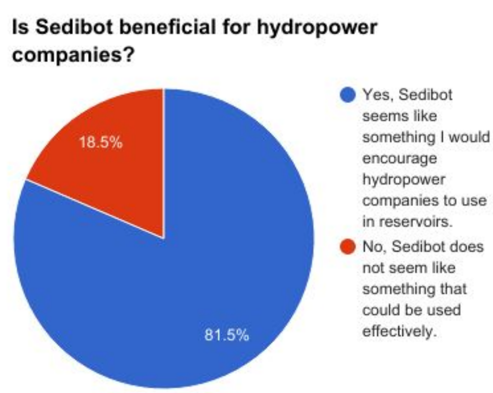
Our solution to fix the sedimentation problem in reservoirs is called "SediBot". We prototyped this design using VEX parts and programmed its operation. The machine is similar to an underwater drone that will use two propellers and a rudder in the back to control its propulsion. In the front, a flashlight and ultrasonic sensor will be installed so that the Sedibot will be able to detect sediment particles in reservoirs and capture them. When the ultrasonic detects debris floating in front of it within a certain distance, a VEX motor turns the front gate open. Once the front gate opens, water flows through a central cavity and two different filtering nets. The first net, at the front, blocks out trash, fish, and plants from being picked up. The second net, at the back, captures sediment but lets water flow through. After a certain amount of time (or, in real life, a certain mass of sediment captured) a secondary gate, located in the back, is lowered down, trapping the sediment in the back and preventing the net from moving too much. We designed the gate using a VEX motors and winch system. When used in real life, the robot would then return the sediment to shore, emptied, then returned to the water. In our real prototype, we would use materials that could endure water pressure such as steel or titanium, similar to those used in submarines. We would waterproof the outside hull and protect the electronic components with plastic coverings. Our nets would also made of strong materials like nylon.



View of back panel and net- back panel supports net in keeping sediment in once robot surfaces.







Many people thought that Sedibot would be beneficial for hydropower companies, since Sedibot is able to increase the lifetime of reservoirs. Also much more people thought that Sedibot could be used on a large scale basis, due to its use of durable titanium or steel.

Program Summary

```
task main()
{

while(1==1) //creates a forever loop that constantly checks for when the bumper switch is pressed
	{
	SensorValue[dgtl12] = 0;
	if (SensorValue[dgtl3] == 1) // this will be a button that tells the SediBot to turn on
		{
		motor [Propel1] = 17; // the motor here and below will be attached to propellors in a real prototype that propel the machine
		motor [Propel2] = 17; //
		motor [port1] = 127; // tells the flashlight here and below to turn on in order for our sensor in the front to be able to see what's in front of it
		motor [port10] = 127; //
		SensorValue[dgtl12] = 1; // the lED will signify that the machine is turned on and ready to go
		onbutton = 1; // sets this variable to 1 so that other parts can be checked later on in the code
		wait(0.5);
		}

	while (onbutton ==1)
		{
		if (SensorValue[dgtl1] < 200 && SensorValue[dgtl1] > 0) //this value here tells our Ultrasonic sensor that if anything comes close than that range,
it will tell our gate flap to open.
			{
			motor [port6] = -30; //here and below to line 59 are a set of commands that involve moving our motor at a controlled cadence to capture
sediment.
			wait (.4);
			motor  [port6] = 0;
			wait (2);
			motor [port6] = 30;
			wait (.4);
			motor  [port6] = 0;
			}
		if (SensorValue[dgtl3] == 1) //this if function stays in the while loop so that it can be read
			{
			onbutton = onbutton + 1; // once pressed it adds one to our global variable that turns our machine on or off.
			}
		}
		while (onbutton == 2) //here are a list of shut down commands that turn off our robot once our on button is pressed again
		{
		motor [Propel1] = 0; // the motor here and below will be attached to propellors in a real prototype that propel the machine
		motor [Propel2] = 0;
		motor [port1] = 0; // tells the flashlight here and below on line 63 to turn off.
		motor [port10] = 0;
		SensorValue[dgtl12] = 0;
		motor [port4] = 35; // the code here through line 88 control our back gate, that raises once our program ends, so that our client can remove
sediment from the SediBot
		wait(0.5);
		motor [port4] = 0;
		wait(2);
		motor [port4] = -35;
		wait(0.5);
		motor [port4] = 0;
	  onbutton = 0; //sets 'onbutton' to 0 and stops the code.
		}
}
}
```

Our program for the SediBot is very simple and can be divided into three sections. The first part noted by “while (1==1)” instigates the code by telling our machine to check to see if our button is pressed, which turns our vehicle. The SediBot prototype must be practical and so we placed 2 motors and flashlights in our demo that turns on when the button switch is pressed. Next, a variable is set to 1, telling our ultrasonic to begin searching for objects within 200mm (for the purpose of our demo, as it can be changed later). The code here then commands our gate flap to open up so that suspended pieces of sediment are trapped and then the gate closes. The last part of our code begins once our button switch is pressed again, setting our ‘onbutton’ variable to 2, which tells our motors and flashlights to turn off. Everything now resets and can restart since we did not use the command ‘break’ which would require our client to turn off and on the cortex and redownload the code.

Key Contributors

Mark Kong -

For the duration of the project I worked on the program, part of our machine, documentation, our presentation, and overall brainstorming of the Sedibot. Primarily, my focus went towards building the back end of our machine and helping with the program. I collaborated with Loic and Jeffrey when designing our Sedibot, solving the problem with our front gate flap and motor propulsion. On the programming side, I kept in touch with Loic and Jeffrey while communicating with Sean to perfect our program. I would comment out sections that I finished or modified and then Sean would take a look at my work in his seventh period POE class and try to add anything to make the Sedibot function properly. In terms of documentation and research, I didn't have a primary role here, and researched our problem in order to write about it for our presentation. Then I would later look our sources over to prepare for our upcoming presentation. In conclusion, our team performed very well together and no one fought about ideas since everything was communicated clearly.

Sean Tseng -

For this project, I mainly contributed to working on the research summary and prior solutions for this project. I also worked on the program with Mark in order to build the base of the code and the main functions of the code. I would also make sure that the program is running smoothly during my period and also added a counter to the program in order for the program to properly function. Also, I worked on the solution summary on the document and created the graphs for our product analysis based upon the data we collected. My primary role was to work on the research summary and prior solutions of the document, and to also help program the code.

Loic Scomparin -

During this project, I worked as team leader to provide the most efficient working experience to complete our prototype and documentation on time. I created the Gantt chart for the project and collaborated with Mark, Jeffery, and Sean to make sure that we were all on the same page and contributing valuable ideas to the design. For example, when my idea for the robot's sediment collection system didn't work, I collaborated with the team and we agreed on Mark's idea, which eventually led to the final design. Most of my time was spent building the prototype with Jeffrey, but I also created the consumer survey and contributed to the design brief, research summary, and solution summary in the documentation. During the actual building, I focused the flap-door systems at the front and back ends of the robot that would automatically open and close to retain or released captured sediment, while agreeing with Mark on sensor placement that would render the robot's program most effective.

Jeffrey Tian -

For most of the project I had a mixed bag of tasks. I first worked with the entire team to help brainstorm ideas. Mark, Loic and I focused on coming up with different ways to allow water into the machine but without have the water remain trapped inside. Once we had decided on an idea, I helped Loic construct the machine. Most of my contributions involved building the machine with Loic and wiring the electrical components. I attached motors and sensors and nailed the cortex under the machine. After the machine was around halfway complete, I began working on documentation and presentation work. I constructed the first introduction slides to our problem and previous solutions along with Mark. I also added the cost estimates and improvements slide on our presentation.

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