Educational Hydraulic Model

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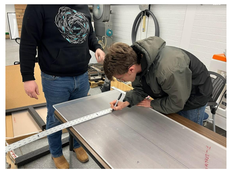
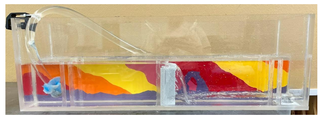
SUMMARY

The Utah State Engineering Ambassadors tasked our team to develop a tool to showcase hydraulics in civil engineering. This tool will travel with the Ambassadors to a wide variety of event with hope of sparking interest in engineering.

The team:

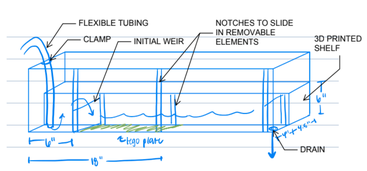
- Evaluated alternatives based on the client's criteria
- Created plans for the recommended alternative
- Prototyped and constructed a full-scale hydraulic model
- Delivered the model and instructional booklet to the client





ALTERNATIVES

1. **New model**
   - Design and build a completely new, customizable model
2. **Modify existing model**
   - Fix issues with an existing abandoned model
3. **Educational videos**
   - Film lesson plans using existing flumes in the USU hydraulic lab
4. **Do nothing**



ASSESSMENT

Priority criteria from the client:

- Engaging for a middle school target audience
- Transportable within an average sedan
- Easy to operate in a wide range of venues
- Allows for future presentations to be added

Alternative Decision Matrix

Decision Factors		Factor Weight	New Model		Modify Existing		Videos		Do Nothing	
			Raw	Weighted	Raw	Weighted	Raw	Weighted	Raw	Weighted
1	Engaging	25%	4	1	3	0.75	1	0.25	2	0.5
2	Transportability	20%	3	0.6	2	0.4	4	0.8	1	0.2
3	Usability	15%	3	0.45	2	0.3	4	0.6	1	0.15
4	Maintenance & Operation	10%	3	0.3	2	0.2	4	0.4	1	0.1
5	Longevity	10%	4	0.4	3	0.3	2	0.2	1	0.1
6	Overall cost	10%	1	0.1	3	0.3	2	0.2	4	0.4
7	Customizability	5%	4	0.2	3	0.15	1	0.05	2	0.1
8	Sustainability	5%	1	0.05	3	0.15	2	0.15	4	0.2
Total Score:				**3.1**		**2.55**		**2.65**		**1.75**

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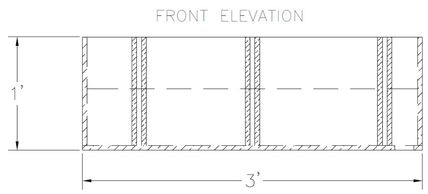
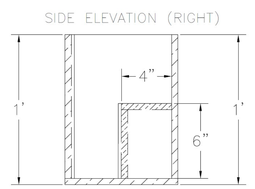
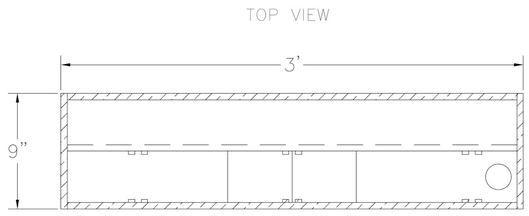
PREFERRED ALTERNATIVE

Based on the result of our decision matrix, the preferred alternative was to construct a new hydraulic model. The specifications of the model are a 36" x 9" x 12" tank with a 4" channel. The tank is constructed out of acrylic for visibility and the various hydraulic elements are either 3D printed or made from acrylic. Three groove sites are positioned along the channel allowing for elements to be interchangeable. The water flows through a pump sitting at the bottom of a bucket, through flexible tubing leading into the model. After passing through the channel, the water drains back into the bucket. The model is currently capable of demonstrating the presentations described in the following section.

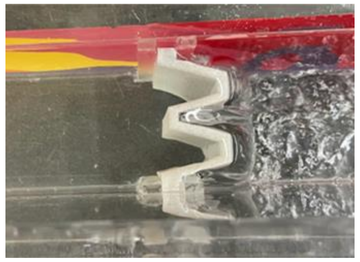






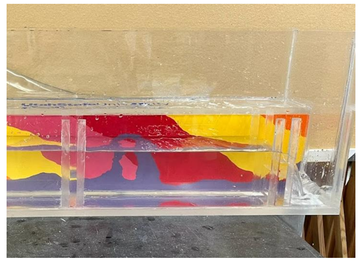
PRESENTATIONS

Weir Capacities



A comparison between a linear and labyrinth weir and how efficiency can affect flooding.

Contractions



A visual representation of how velocity can be changed by manipulating the area of the flow.

Hydraulic Jumps

A demonstration on the danger of submerged jumps and how tailwater can affect the jump position.

Scour Reductions

A hands-on experiment about how baffle blocks dissipate energy and lower turbulence downstream.

FUTURE APPLICATION

The model was made to adapt and change for different presentations. The interchangeable parts allow the client to create new presentations and add new elements.

Additional Presentations Ideas:

- Use a sponge to look at infiltration and flow through soil
- Add a culvert attachment
- Add more weir types (PK, broad crested, OG, etc.)
- Add fish pebbles to demonstrate sediment transport
- Add houses and trees to the shelf to better represent flooding
- Make small boats to send through the model
- Do a presentation on hydrostatic pressure

SUPPORT

Our team is very grateful for the opportunity to create this model. A special thanks to all the following for making this project possible!

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Professor Austin Ball, P.E., *Utah State University*
Ken Jewkes, *Utah State University*

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