Patrick Wessels
Flow Visualization
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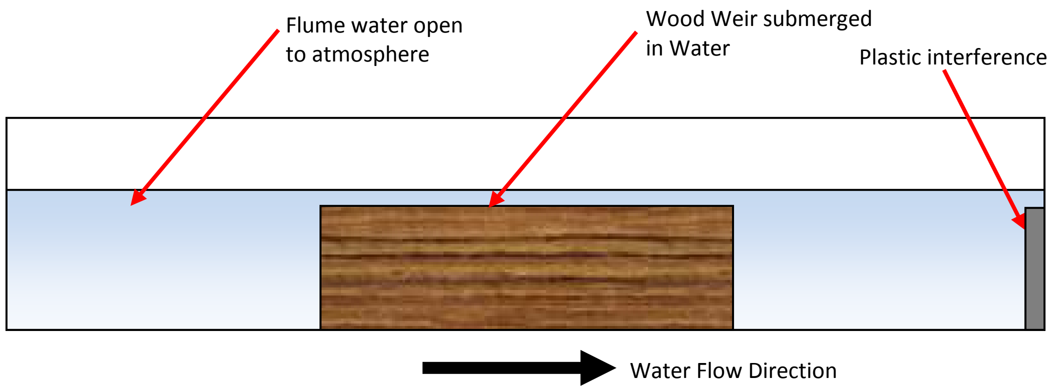
video:
640 :frame width
480 :frame height
5840 kbps: data rate
6032 kbps :total bitrate
29 fps
.wmv :format

audio:
192 kbps
2 :channels
48 kHz :audio sample rate
Love Like a Sunset :song
Phoenix :artist

Group Image 1: Flume Weir Interaction

This image was created to show fluid behavior in the water flume. The intent of this particular image was to capture the water surface effects as passing over a change in cross section. As our group was trying to capture streamline effects of water and dye interaction, we had noticed this interesting interaction on the surface of the water on top of the wood weir. This phenomena was not intentionally sought after, but was so interesting and unexpected that it surprised all of us in the group.

This photo was taken in a flume in the basement of the ITL. A wood weir was placed in the middle of the flume and water was allowed to flow over the top of the wood block. As the flow rate was very slowly increased, this surface effect was visible, but during the video, a constant flow rate was maintained. The main channel water depth was 10.8 cm and the height of the water on top of the weir was 1.3 cm. The wood weir was 20.0 cm long. The water was flowing at a rate of 20 cm/s on top of the weir. A setup of the experiment can be seen in the schematic below.



The Reynolds number for this flow was determined to be:

$$Re = \frac{\rho v D}{\mu} = \frac{(1000\ kg/m^3)(.2\ m/s)(.013m)}{(1.0e^{-4}\ Pa * s)} = 2600$$

This Reynolds number corresponds to a flow that is in the transition region from being laminar to being turbulent flow. The surface phenomenon that is seen in the image, is a result of fluids traveling at higher velocities have lower pressure than the same fluid traveling at slower speeds[1]. The Bernoulli principal relates the velocities and the pressures along a streamline can be related to each other. This is shown below as the velocity increases the pressure must drop as well.

$$P_1 + \frac{1}{2}\rho {V_1}^2 = P_2 + \frac{1}{2}\rho {V_2}^2$$

In my image this drop in pressure is shown by the water level decreasing as the velocity increases. The velocity increases as the water travels over the weir due to conservation of mass around the controlled volume.

The visual technique used here was to use the reflective surface of the water to pick up on the brown texture of the wood weir. When doing this, the water surface/imperfections are visible. The style of the image was to emphasizes the very horizontal flat water line, with the pressure difference visible as bumps on the surface. Back lighting of 500W was used to mute out a neutral color background. This light was place approximately 3 feet way from an opaque acrylic background.

For the image, I tried to keep the water line in the frame at all times, by panning up and down. The camera is 4 inches away from the wall of the flume. The video was taken at 640x480pixels at 29 fps on my Cannon PowerShot SD870 IS. The default video setting was used when creating this shot. The video was imported into my computer and edited with Windows Movie Maker. In the software, I repeated the loop and added audio from a band called Phoenix.

I hope that the image reveals the pressure effects of the water as it changes velocity. The image should create an illusion of false and changing horizons. The panning technique I believe was effective, but because of that, the reflections off the walls of the flume are quite evident when doing this. I experimented with several images, but in the end I was most pleased with capturing the effect with a video.

1. http://www.princeton.edu/~asmits/Bicycle_web/Bernoulli.html