Get Wet Project 1
MCEN4228 – Flow Visualization
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Capturing the movement of fluids at an instance in time can produce images with both scientific as well as artistic significance. As the first foray into visualizing fluid flow, more emphasis was placed on photographic and image enhancement techniques through the use of a digital camera and Adobe Photoshop. The specific fluid dynamic that was being observed was steady laminar flow. Marginal results were experienced when attempting to create a wide section of laminar flow in a controlled experimental setting. Many example of fully developed laminar flow can be found quite easily in nature, which is the basis for the image.

The fluid flow was observed as a fully developed laminar flow passing over a simple solid body. The solid body was a six-foot wide hydro dam located at the west end of Ebin G. Fine Park in Boulder Colorado. Above the dam is a large body of slow moving water, which by basic fluid dynamic principles represents laminar flow. The Reynolds number was calculated to be around 250, well below the transitional level from laminar to turbulent flow. Non-uniformity of the flow along the wall can be attributed to the dam wall construction. Small pebbles that disrupt the flow pattern cover the leading edge of the wall. The flow changes to turbulent flow at the top of the image due to the water impacting a flat surface perpendicular to the flow direction. Refer to Figure 1 to see a complete image of the dam wall.

Indirect sunlight on an overcast day was used as the primary lighting with the built in flash used to add additional highlights. The camera was positioned two feet above the dam flow looking directly down towards the leading edge of the wall. No dye or tracer was used to track the streamlines due to the natural visibility of the water's reflection.

The field of view is approximately twelve inches by twelve inches and the camera is approximately two feet above the fluid flow. An Olympus X-3, 3megapixel digital camera was used with an exposure time of $1/40^{th}$ of second and an f-stop of 2.8. The focal length of the lens was 7.8mm.

Photoshop was utilized to enhance the image and create more of a contrast for the streamlines. The levels as well as the hue saturation were manipulated to create the desired effect and the change of colors.

The image reveals fully developed laminar flow over a wide solid body. How the laminar flow is non-uniform as a result of the pebbles creates a random fluid form which adds a dimension of complexity to the image. One regret is that the shutter speed could have been much faster with more direct lighting or a 35mm camera with faster speed film. Capturing an image of a short time period would possibly provide much more clarity to the turbulent side of the fluid flow.

On the last page is another image titled, "Getting my feet wet" which was taken in a section of laminar flow water in the same location as the dam. The fluid can be seen as it contacts with the two bluff objects and becomes turbulent on the other side. The neon filter in Photoshop was used to emphasize the flow dynamics.

Figure 1 - Dam wall

Figure 2 - Original Image pre-photoshop

Figure 3 - "Getting my feet wet" Flow around bluff bodies - Neon Filter

Image Assessment Form
Flow Visualization
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Scale: +, ! = excellent √ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Instructor assessment
Intent was realized	√	
Effective	√	
Impact	~	
Interesting	!	
Beautiful	!	
Dramatic	√	
Feel/texture	√	
No distracting elements	√	
Framing/cropping enhances image	√	

Flow	Your assessment	Instructor assessment
Clearly illustrates phenomena	√	
Flow is understandable	√	
Physics revealed	~	
Details visible	~	
Flow is reproducible	~	
Flow is controlled	~	
Creative flow or technique	~	
Publishable quality	X	

Photographic technique	Your assessment	Instructor assessment
Exposure: highlights detailed	√	
Exposure: shadows detailed	√	
Full contrast range	√	
Focus	√	
Depth of field	~	
Time resolved	X	
Spatially resolved	~	
Clean, no spots	√	
OK, simple print	NA	
Mat	NA	
Mounting	NA	

Report		Your assessment	Instructor asssessment
Describes intent	Artistic	√	
	Scientific	√	
Describes fluid phenomena			
Estimates appropriate scales	Reynolds number etc.	√	
Calculation of time resolution etc.	How far did flow move during exposure?	NA	
References:	Web level	X	
	Refereed journal level	X	
Clearly written`		~	
Information is organized		~	
Good spelling and grammar		√	
Professional language (publishible)		X	
Provides information needed for reproducing flow	Fluid data, flow rates	~	
	geometry	√	
	timing	√	
Provides information needed for reproducing vis technique	Method	√	
	dilution	NA	
	injection speed	NA	
	settings	NA	
lighting type	(strobe/tungsten, watts, number)	~	
	light position, distance	√	
Provides information for reproducing image	Camera type	√	
	Camera model	√	
	Field of view	√	
	Focal length	√	
	aperture	√	
	shutter speed	√	
	film type and speed	NA	
	# pixels (width X ht)	√	
	Photoshop techniques	~	
	Print details	~	
	"before" Photoshop image	√	