Today
Start specific FV techniques. Dyes

Admin
- April 3, 1 – 3 p.m. – Norlin Library E260
  Photoshop CS6 – De-Mystify Photo Editing
  Audience: Faculty, staff, and students wanting to gain a greater understanding of digital imaging, video editing, and image.

In this 2-hour hands-on workshop participants will learn how to use Photoshop CS6 to quickly correct, blur, and create amazing photo effects. We will also build a short video using Photoshop's new video editing technologies.

Individuals with colorado.edu accounts may sign up here:
https://www.colorado.edu/oit/node/11251.

- Invite friends, family to Lobby Show Friday 5/3, 2 pm-4pm. Help set up at 1 pm. Not required, but fun to show off your work this semester

Minute paper: Group dynamics. Have you been able to meet? If not, why not?
What can be done?

SPECIFIC FV techniques
- Boundary techniques. Boundary between 'seeded' and unseeded fluid.
- Choice depends on physics desired
  1. DYES Today. Mostly in water.

In this class, often visualization technique determines physics examined, but usually physics are determined by system under study, and FV technique applied should not disturb the flow/physics

  1 Dye Considerations:
  1) Want dye to NOT disturb flow
  2) Want dye to show up - HIGH VISIBILITY
  3) Special techniques

  1) Not Disturb flow "How?"
  Minute paper - Groups

  Match fluid properties, including velocity(speed and direction)
  - Density
  - Viscosity
  - Polarity, miscibility; (will it mix)
  - Pressure
  - Temperature
  - Contrast
  - Molecular weight
  - No chemical reaction
  - Match vorticity as well as velocity
  - Inject upstream of test section
  - Allow for equalization time

  Answers:
  - Match flow speed when injecting
  - Use small ports, minimize volume injected,
  - Consider location of injection; reveals different physics http://media.efluids.com/galleries/laminar?medium=113
Avoid injection altogether: Coat object with alcohol-dye mixture, let dry, then tow in tank. Shows vorticity layer, wake, boundary layer.
Or coat short strings on a rake. OK for low speed, short run times.

- Match fluid properties between dye and medium
  - Density
  - Temperature
  - Viscosity
  - Surface tension (match intermolecular forces)
  - Minimize chemical reactions (unless needed)
  - Diffusion coefficient


**Figure 4.** Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (a) Nigrosine dye was added to the top stream. (b) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly mix (here, “pink” is shown as dark regions within the mixing layer).

Difficult to match all these properties - dye properties are different from ambient fluid.

To match density, try a premix:
- For food dye in water, premix dye (dense, sinks in water) and isopropyl alcohol (floats) to get neutral buoyancy in water

The concentration gradient between dyed and undyed fluid may cause dye to diffuse too rapidly, misleading when studying mixing. Turbulence also causes fast diffusion, making visualization of the overall flow structure difficult. Try some milk or latex paint to slow diffusion.

Famous example:
Cloud tank was invented by Douglas Trumball to make realistic clouds in
'Close encounters of the third kind' (1980's sci-fi). Used many times since:
http://www.youtube.com/watch?v=2Ps0iXwS60E

More info in Special Effects article

2) Want dye to show up - HIGH VISIBILITY

High Visibility: Want good contrast between dyed and ambient fluid.

- Ambient fluid = transparent = NO interaction with light
- Dyed fluid = want MAXIMUM interaction with light

Minute paper: list the ways that dye (or any molecule) can interact with light (from external source, later will talk about emitted light)

- Refraction
- Absorption
- Diffraction
- Reflection
- Scattering/diffusion
- Transmission

- Transmit
  - Refract
  - Transmitt
  - Diffuse

  Diffuse transmission and reflectance.
  http://library.thinkquest.org/28262/manii.html

- Reflect
  - Specular
  - Diffuse, scatter

- Diffact: Like refract, but with constructive/destructive interference

http://www.me.ted.ucar.edu/marine/ripcurrents/NSF/media_gallery.php
http://www.tufts.edu/as/tampl/projects/micro JSX/theory.html
Absorb

- Absorb
- Big 4: Refraction, reflection, diffraction, absorption.
- Disperse, any of these, but
  - Affect differently based on wavelength
    - leads to chromatic aberration, prisms, cloud iridescence (diffraction around particles; interference)
    - Birefringence = 2 indexes of refraction

Make sure lighting and backdrop are appropriate for the type of light interaction.

E.g.:
Dye = dark food color: Absorption is primary, so use bright backdrop
Dye = milk: Scatter is primary; use black backdrop

Minute paper: Which is better for a dark backdrop: smooth or rough/matte?
Smooth is good if you can control what the specular reflection shows. If not, rough is better.