Report Guidelines

01/20/11

Flow Visualization: The Physics and Art of Fluid Flow

All work must be submitted on CULearn, with the exception of the self-assessment document, which can be hardcopy.

The baseline goal of the report is to provide context for the image, and enough documentation that the image could be re-created. Arts students are expected to meet this goal. Undergraduate engineering students will be expected to write the report in a professional fashion, and graduate engineering students are expected to produce a document of publishable quality. The report is expected to be 1 page in length at a minimum, four pages maximum. Use a descriptive narrative, rather than a list of items.

First Paragraph: Give the context and purpose for the image. For example, second project, group working on flume. Describe the intent of the image, what phenomenon you were trying to see. OK to mention false starts here, but the rest of the report should only deal with the final image. Assume the report will be read by strangers who know nothing of the course.

Second Paragraph (or more): Describe flow apparatus used in the image, and refer to a sketch. Engineering students should do the sketch in Powerpoint or equivalent. Describe the basic flow, i.e. flow over a submerged obstacle, flame impinging on an orange, turbulent boundary layer on a wing, etc. Give size or scale of object, width of channel, etc. Then discuss the flow itself.

Expectations for flow discussion vary with student category. All students should think in terms of forces acting on the fluid: why does it look like that? If it is changing with time, why? What forces are making it move? Arts students are expected to describe what they did in enough detail that somebody else could repeat it for a similar result. Engineering students should estimate appropriate nondimensional scales: Reynolds number, Grashof number, etc., as well as the required time and spatial resolution based on flow speed and field of view. Include the symbolic calculation as well as the numbers and units you used. For example (in water):

$$Re = \frac{UD}{\upsilon} = \frac{\left(0.1\frac{m}{s}\right)(0.05\,m)}{1.004\ \times 10^{-6}\frac{m^2}{s}} = 5000$$

where the velocity scale was chosen because…. etc. Please use proper significant figures in the result.

Engineering students should research the phenomenon at least at the web level. Graduate ME students are expected to discuss additional context for the flow physics and give at least two references to the archival (refereed) technical literature. Finding a fluid property in a textbook is not a sufficient investigation of the physics in the literature. All students should think in terms of forces acting on the fluid: why does it look like that? If it is changing with time, why? What forces are making it move?

Any information about the flow that you get from publications or the web needs to be properly cited. See the examples at the end of this document.

Third Paragraph: Describe the visualization technique used: Dye, smoke etc. Specify details such as exact source of materials, any relevant environmental conditions. Give dilutions if appropriate. In second part of paragraph, describe the lighting used: flash on camera, bright sunshine, flame emission, etc. Again, the minimum goal is to provide enough information for the image to be repeated.

Fourth Paragraph: Describe the photographic technique, and **why** you made the choices you did.

- Size of the field of view
- Distance from object to lens
- Lens focal length and other lens specs.
- Type of camera: film or digital, including original and final image width and height in pixels, then give make and model.
- Exposure specs: Aperture, shutter speed, and ISO setting
- Photoshop processing. Describe manipulations, settings. If used, provide a "before" image too.

Most digital cameras automatically record the exposure and lens specs in the image file. Info can be viewed in Photoshop: File menu, File Info, Section:EXIF.

Fifth Paragraph: Describe what the image reveals. What do you like and dislike about the image? How well are fluid physics shown? What questions do you have? Did you fulfill your intent? What aspect would you like to improve? What direction could you go in developing this idea further?

Complete a self assessment of the image and report, and attach to the report. Assessment forms can be downloaded from the class website.

Cloud Image Reports

First Paragraph: Give the context and purpose for the image. For example, second cloud assignment. Describe the intent of the image, what phenomenon you were trying to see. OK to mention false starts here, but the rest of the report should only deal with the final image. Assume the report will be read by strangers who know nothing of the course.

Second Paragraph: Describe the circumstances of the image:
Location
Direction and elevation (angle from horizontal) camera was facing
Date and time of day

Third Paragraph:
Statement of what clouds are in the image.

Appearance of the rest of the sky, and previous and expected weather. Was there a front approaching? Had the clouds been similar the day before? Did it rain or snow within a few hours of the image? Winds?
Discussion of the stability of the atmosphere. Include the closest skew-T plot. Discuss what cloud heights could be expected, and whether that agrees with your observation. What types of clouds would be expected from the stability and the general weather. Is that what you observed in your image? Estimate the elevation of the clouds. Describe winds aloft if appropriate. Discuss the physics leading to the imaged clouds.

Be careful to use the right skew-T plot. If you want today's 6 pm sounding, it should have a timestamp of 00Z *with tomorrow's date*. Links to the archives are on the Flow Vis website.

Fourth Paragraph: Describe the photographic technique, and what influenced your choices

- Estimate the size of the field of view
- Distance from object to lens
- Lens focal length and other lens specs.
- Type of camera: film or digital, including original and final image width and height in pixels, then give make and model.
- Exposure specs: Aperture, shutter speed, and ISO setting
- Photoshop processing. Describe manipulations, settings. If used, provide a "before" image too.

Most digital cameras automatically record the exposure and lens specs in the image file. Info can be viewed in Photoshop: File menu, File Info, Section:EXIF.

Fifth Paragraph: Describe what the image reveals. What do you like and dislike about the image? How well are fluid physics are shown? What questions do you have? Did you fulfill your intent? What aspect would you like to improve? What direction could you go in developing this idea further?

Complete a self assessment of the image and report, and attach to the report. Assessment forms can be downloaded from the class website.

Reference and Citation examples

There are two common styles for citations; alphabetical and numbered. Here are examples of each

Alphabetical

Diethyl phthalate is a good choice for cardiovascular modeling because of its high index of refraction and low viscosity. This is coupled with a health hazard rating of 1, flammability rating of 1 and a reactivity rating of 0 (Fischer 2005). DEP is a commonly used plasticizer, present in many household products, and is not a health hazard according to a current toxicological review (Api 2001). There has been some controversy about its effects on human health (Colon et al. 2000; Hill et al. 2003; Sonde et al. 2000) but this can be mitigated by simple laboratory procedures including handling with gloves and adequate ventilation. It is also relatively inexpensive at approximately $16 per liter (Fischer 2005).

You could also use the citation in a sentence like " Fischer (2005) found that …."
At the end of the report, give the correct reference for each citation. Don't include a reference unless you cited it in the text. Make it as complete as possible, so it's easy for somebody else to look up. List each in alphabetical order, by first author and year:

Fischer Scientific (2005) http://www.fischerscientific.com
Forsythe W (ed) (1954) Smithsonian physical tables, 9th edn. The Smithsonian Institution, Washington
Giner J, Ibarz A, Garza S, Xhian-Quan S (1996) Rheology of clarified cheery juices. J Food Eng 30:147–154
Hill S, Shaw B, Wu A (2003) Plasticizers, antioxidants, and other contaminants found in air delivered by PVC tubing used in respiratory therapy. Biomed Chromatogr 17:250–262

Numbered

Vortex/wall interactions are found in many fluid systems,[1] particularly in aerodynamic applications. For example, a vortex generated on the surface of a maneuvering airfoil during a dynamic stall process can interact with the airfoil surface, affecting the aerodynamic properties.[2–4] Vortex/wall interactions have also been studied as an important element of turbulent boundary layers:[5–7] the legs of a

[1]T. L. Doligalski, C. R. Smith, and J. D. A. Walker, ‘‘Vortex interactions with walls,’’ Annu. Rev. Fluid Mech. **26**, 573 (1994).
[2]W. J. McCroskey, ‘‘Unsteady airfoils,’’ Annu. Rev. Fluid Mech. **14**, 285 (1982).
[3]M. S. Francis and J. E. Keesee, ‘‘Airfoil dynamic stall performance with large-amplitude motions,’’ AIAA J. **23**, 1653 (1985).
[4]L. Carr, ‘‘Progress in analysis and prediction of dynamic stall,’’ J. Aircraft **25**, 6 (1988).

You can use superscript numbers as shown, or numbers in brackets [1]. However you do it in the text body, use the same format in the reference list.

There are tools to help with this; the Endnote feature in Word, or the program ‘Endnote’. There are database systems as well. Zotero, which works within Firefox, keeps track of all kinds of references, and inserts them into Word in whatever format you need. Refworks is similar, and works well with the CU Library system.