AME 514 Applications of Combustion - Spring 2017

Assignment #5

"Due" Friday April 28 (but assignments will be accepted with no late penalty until Wednesday May 10 at 4:00 pm) in the drop box in OHE 430N (Xerox room in the OHE 430 suite of offices.) While hard copies are preferred if you're off campus, you can email your assignment to ronney@usc.edu. DEN students should submit through the usual channels. NO ASSIGNMENTS ACCEPTED AFTER MAY 10 AT 4:00 PM!

Part 1: paper review

Read any of the research papers listed below. **For your convenience, most of the papers are available on the class website in the /LectureN/ folder, where N = 13 or 14**

Clavin, P., Masse, L. (2004). "Instabilities of ablation fronts in inertial confinement fusion: A comparison with flames." *Physics of Plasmas* 11:690-705.

Clavin, P., Williams, F. A. (2004). "Asymptotic Spike Evolution in Rayleigh-Taylor Instability." *J. Fluid. Mech.* 525:105-113.

Gamezo, V. N., Khokhlov, A. M., Oran, E. S., Chtchelkanova, A. Y., Rosenberg, R. O. (2003). Thermonuclear supernovae: Simulations of the deflagration stage and their implications. *Science* 299, 77-81.

Gamezo V. N., Khokhlov A. M., Oran, E. S. (2004). Deflagrations and Detonations in Thermonuclear Supernovae. *Phys. Rev. Lett.* 92, Art. No. 211102.

Kök, M. V., Guner, G., Bagci, S., *Oil Shale*, Vol. 25, No. 2, pp. 217–225 (2008). Paper on *in situ* combustion of oil shale for oil production.

Kocha, S. S. Yang, J. D., Yi, J. S. (2006). "Characterization of Gas Crossover and Its Implications in PEM Fuel Cells. *AIChE J.* 52:1916 – 1925.

D. Lieberman, J. Shepherd, F. Wang and M. Gundersen (2005). "Characterization of a Corona Discharge Initiator Using Detonation Tube Impulse Measurements," AIAA Paper 2005-1344.

O'Regan, B. and Grätzel, M., Nature 343, 737-740 (1991). First paper on dye-sensitized solar cells. Over 10,000 citations! (Caution: this paper is "challenging" because many of the terms and concepts are unfamiliar to most people in this course (including me.))

Shaver, G. M., Gerdes, J. C., Roelle, M. J., Physics-Based Modeling and Control of Residual-Affected HCCI Engines," *ASME Journal of Dynamic Systems, Measurement, and Control*, Vol. 131, 021002 (2009).

E. D. Tolmachoff, A. D. Abid, D. J. Phares, C. S. Campbell, H. Wang (2009). "Synthesis of nano-phase TiO_2 crystalline films over premixed stagnation flames," *Proc. Combust. Inst.* 32, pp. 1839–1845. Key paper on combustion synthesis of nanometer-sized TiO_2 partciles for dye-sensitized fuel cell applications.

L. F. Valadares, Y.-G. Tao, N. S. Zacharia, V. Kitaev, F. Galembeck, R. Kapral, and G. A. Ozin, "Catalytic Nanomotors: Self-Propelled Sphere Dimers," Small, Vol. 6, pp. 565–572, 2010. (Yes, "Small" is the title of the journal.) Very interesting paper on self-

propelled nanoparticles.

E. Wintenberger, J. M. Austin, M. Cooper, S. Jackson, J. E. Shepherd (2001). "An analytical model for the impulse of a single-cycle pulse detonation engine," AIAA paper no. 2001-3811.

Prepare a critical review of the article, preferably not to exceed 2 pages, structured as follows (same format as previous paper reports). PLEASE IDENTIFY EACH SECTION WITH A HEADING.

1) Why the author(s) conducted the work – what did they intend to do that was **new** at the time?
2) Summary of the methods used
3) Summary of the most important results
4) Summary of the conclusions
5) Your opinion of the merits of the work
6) Your opinion of the shortcomings of the work
7) ONE sentence summary of the **most important message** the authors were trying to convey.

Part 2: "White paper" research proposal

Since the "emerging topics" part of the class does not lend itself well to the usual type of homework or exam questions, this part of the homework assignment takes the place of a question on the in-class final exam. Think of this as a "take home" part of the final exam.

This section of the course considers recent developments and emerging technologies in reacting flows. Thus, I think it is only reasonable that you try to identify your own "niche" in one of these emerging areas. Prepare a "white paper" (basically a highly compressed, top-level, research proposal), structured as follows (e.g. one paragraph for each bullet item; some bullets may be combined into one paragraph):

- State what your topic is and why it is important
- State what is known about the subject
- Complain about what is lacking in the current state of knowledge
- Explain what you would do that would improve the state of knowledge (i.e. specifically what computer simulation or experiment or analysis you would perform)
- Describe how you would analyze or interpret the data once you had them
- Speculate as to what results you might obtain
- State how these results would advance the state of knowledge of the field
- List your **references**

I am looking for about 2 – 3 pages but I won't set a specific page limit. You may want to include a couple of key figures that would increase the page count. In the real world white papers are almost never allowed to be more than 2 pages including figures. Also in a "real" white paper you would also need to include a statement about budget and schedule but you don't need to do that for this assignment.

Example white paper: http://ronney.usc.edu/AME514/SampleWhitePaper.pdf

I am NOT looking for a "position paper" about how important a subject is and in general terms what type of research should be done, nor a whole development program to design a new hypersonic propulsion aircraft or a PEM fuel cell powered vehicle. I am looking for a specific, concrete, idea of narrow scope and specific means to test the idea, maybe one that could be accomplished with a "one faculty member, one postdoc and two graduate students" level of effort.

Also, if you're going to use a numerical model, just saying, "numerical modeling will be done and compared to experimental results" isn't enough. You need to state what model predictions will be compared to experiments. Also, you need to state what equations will be solved (i.e. Navier-Stokes, Euler, incompressible flow), how many dimensions (1, 2 or 3), steady or unsteady, whether you will use a direct numerical simulation or a "modeled" set of equations (e.g. Large Eddy Simulation of turbulence), what type of chemical scheme (1-step, reduced, or detailed mechanism), and what makes you think you have sufficient computing power to get the job done.

To save time and energy you may want to prepare your white paper on the same general topic as your paper review, i.e. you could make your white paper an extension of the paper you reviewed in Part 1 of this assignment. I also expect that you will verify that what you propose hasn't already been done; at a minimum you should check the ISI Web of Science for similar topics. (See the course home page for details on accessing the Web of Science.) It's essential that you **reference** prior work in the field, i.e. what has already been done.

While not required, you may send me a **one-paragraph** summary of the topic you're considering. I'll provide feedback on your topic as quickly as possible but the sooner you get summary to me, the more time you'll have to make adjustments to your white paper.

(This might sound like a strange assignment but trust me, if you do any sort of Research and Development in your engineering career you WILL be preparing "white papers." Get used to it…)

Gjaltema, A., Arts, P.A.M., Loosdrecht, M.C.M., van Kuenen, J.G., Heijnen, J.J. (1994). "Heterogeneity of biofilms in rotating annular reactors: Occurrence, structure, and consequences." *Biotechnol. Bioeng.* 44:194–204.

Gorby, Y., *et al.* (2005). "Electrically conductive bacterial nanowires produced by Shewanella oneidensis strain MR-1 and other microorganisms." *Proc. Nat. Acad. Sci. U.S.A.*, **103**:11358 – 11363.

Kim, B-H., *et al.* (2002). "A mediator-less microbial fuel cell using a metal reducing bacterium, *Shewanella putrefaciens." Enzyme and Microbial Technology* 30, 145-152. (Most cited paper on Kim's work on mediatorless microbial fuel cells).

Myers, C.R. & Nealson, K.H. (1988). "Bacterial Manganese Reduction and Growth with Manganese Oxide as the Sole Electron Receptor." *Science* 240, 1319-1321. (Paper that started the whole subject of microbial fuel cells by identifying the bacteria that can do the job.)