Student's Full Name
Katherine Goodman

Student's Home Department
ATLAS Institute

Student's Email Address
katherine.goodman@colorado.edu

Adviser's Full Name
Jean Hertzberg

Payroll Liaison's Full Name
Vickie Stubbs

Payroll Liaison's Email Address
Vickie.stubbs@colorado.edu

Payroll Liaison's Phone Number
(303) 735-6153

I'm applying for funding for:
Summer 2014
Fall 2014
Spring 2015

By submitting this application, I confirm that, if selected to receive a Chancellor's Award for Excellence in STEM Education, I will:

- ✓ Attend and be recognized at the annual Symposium on STEM Education (fall 2014).
- ✓ Give a brief introduction (~10-15 min) to my project at DBER in fall 2014.
- ✓ Actively engage in the CU-Boulder STEM education community by attending Chancellor's Fellow events.
- ✓ Present my work to the STEM education community by giving at least one DBER seminar, OR, if that is an impossibility, I will give a talk that the CU-Boulder STEM education community is invited to attend.
- ✓ Submit a 1000 to 3000-word report detailing the outcomes of the project at the end of the funding period.

FINDING THE ESSENTIAL ELEMENTS: FLOW VISUALIZATION

Submitted by Katherine Goodman, PhD student in the ATLAS Institute, College of Engineering

Faculty Research Advisor: Dr. Jean Hertzberg, Associate Professor, Mechanical Engineering

Introduction:

Since 2003, the University of Colorado at Boulder has offered Flow Visualization, a course cross-listed as a mechanical engineering elective and a studio fine arts course. This innovative course, developed and taught by Professor Jean Hertzberg, brings together mixed teams of engineering and fine arts photography or film students. It focuses on the production of aesthetically pleasing and scientifically useful images of fluid flows. Students (and colleagues) have responded enthusiastically, with exit survey comments such as "I'll never ignore the sky again" or "I see examples of flow vis all the time now."

Image by Kerylyn Lay; *Cirrus with Kelvin-Helmholtz waves, Friday, March 30, 2012, at roughly 12:00pm, Moab, UT.*

Students in Flow Vis emerge believing that fluid mechanics is more important to themselves as engineers and to society, that is, they have a positive shift in affect. In contrast, Fluid Mechanics, also taught by Professor Hertzberg, is a traditional engineering core course, with a highly analytic, mathematical approach. The equations that govern fluid flow are derived, and students practice solving quantitative problems that have a realistic engineering context. However, there are no such enthusiastic comments on the exit surveys from Fluid Mechanics, and attitude surveys reveal a negative shift in affect, which is typical of other technical courses. In short, evidence supports a positive attitude shift toward fluids after Flow Vis, but not after Fluid Mechanics. This is not only a problem for Fluid Mechanics or even just for engineering courses.

This negative shift in affect is present in many STEM courses, both at CU and other Universities (1)(2).

Goals & Objectives:

Research Question: *What aspects of Flow Visualization facilitate the positive shift in affect? How can these aspects be replicated in other courses?*

This research aims to understand the causes of the positive attitude shift in Flow Vis more clearly, with the ultimate goal of creating a model that can be applied to other engineering and science topics. Throughout this investigation of Flow Vis, I will inquire along four avenues as the possible source(s) of the positive shift in affect:

- the cultural environment of the class
- the pedagogical techniques employed in the course
- the course's emphasis on aesthetics
- the students' development of visual expertise

Background and Significance:

Student affect toward engineering is believed to play a significant role in recruitment and retention. Technical courses in math and science typically cause a negative shift in affect (2–6); students emerge from a course thinking it less useful and important than when they began it, and this effect is largely immune to varying pedagogy. This is why the consistent results showing a positive shift in affect for Flow Vis students merit investigation. These attitude shifts were measured using the Fluids Perception Survey (FLUPERS) (7).

The relationship between educational outcomes and affect and motivation has been extensively studied in the past two decades, although much remains unknown. Qong et al. (8) provide an extensive review of student characteristics, including both extrinsic (e.g. gender) and intrinsic (e.g. self-efficacy) factors that affect enrollment and retention in engineering, but visual expertise and aesthetics have not been considered, and few if any of the studies have included the unusual mix of students present in Flow Vis.

For example, the literature of aesthetics in engineering education falls into two categories: aesthetics related to industrial and structural design (9–13), and to digital technology such as websites and games (14–19). In the education of other types of college students such as teacher candidates and mathematicians, aesthetics is seen as a pedagogical tool to some extent (20–24). Simply put, the intersection of these fields with other areas of engineering and physics education has received little attention to date.

In contrast, there is a rich literature regarding the visual perception of art, fueled by recent advances in biology, psychology and neuroscience (25–29). Most of these texts use paintings or graphics rather than photographs as illustrations, perhaps reflecting photography's relatively new status as an accepted art medium, although Frankel makes an effective plea for more aesthetic photography in scientific literature(30). There is also rich literature in the more utilitarian aspects of vision related to communication of information, such as Tufte's work on the visual display of information (31–33). There is significant research on visual representations of information, and how students use these representations in learning which is geared towards understanding and improving cognitive gains (34–37). Flow Vis students create image that are both aesthetically pleasing and useful for understanding the physics concepts, while engaged in a classroom dialogue that explicitly asks when such blends of art and science are appropriate for scientific uses. (See course syllabus: www.colorado.edu/MCEN/flowvis/course/syllabus.pdf)

Perhaps more importantly, Flow Vis incorporates a number of pedagogical techniques novel in engineering. While the art and film students are conversant in classes that emphasize aesthetics and creativity and include peer critique and public display of their work, these aspects are unfamiliar to the engineering students. Despite aesthetics, creativity, peer critique, and public display of work all having clear roles in engineering practice, these aspects of engineering are not explicitly included in current, typical pedagogical practices.

Course Format:

Flow Visualization brings together engineering and fine arts photography or film students to produce aesthetically pleasing and scientifically useful images of fluid flows. This includes both undergraduates (typically juniors or seniors) and graduate students. The engineering majors use the course as a technical elective, while the arts or films majors typically use the course to fulfill

part of a studio requirement. There are roughly 50 students in the class, which has been offered nearly every spring semester since 2003.

Early in the semester, Professor Hertzberg covers topics such as using the camera and fluid mechanics basics. Later class sessions focus on students presenting work and receiving feedback.

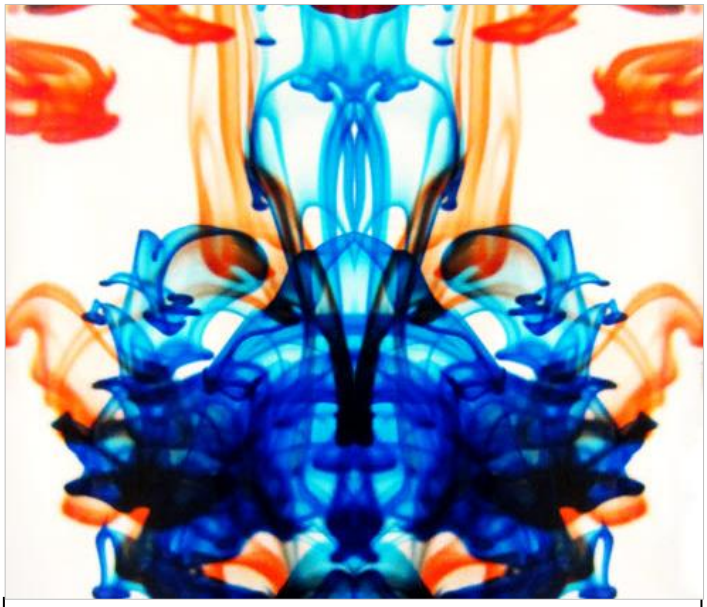

Image by: Trevor Beatty; *Food dye exhibits the Rayleigh Taylor instability, forming toroidal vortex rings in a mirrored image.*

There are six projects over the course of the semester that can be still photographs or short videos. For the first assignment, students work independently, partly to demonstrate the challenge of controlling a flow while documenting it visually. Students also independently photograph cloud formations throughout the semester for two assignments. Students are assigned to teams of four or five using CATME (http://catme.org/) to distribute resources and expertise for the remaining three assignments. For each of these team assignments, students are responsible for creative control of one image/video, while assisting their teammates. Aside from the cloud images, the only specification for image content is that it must document fluid mechanics. Human figures are allowed, but fluids must be the 'star' of the image.

The images or videos are presented during class. Hertzberg and the other students comment on the image, offering critiques. To encourage honest feedback and to ensure all students participate, students may use their laptops to anonymously offer comments.

Each project is accompanied by a short written explanation. In one to four pages, students provide the context for their image such that someone else could re-create it. The write-up includes apparatus, materials, and photographic techniques used, phenomenon demonstrated, and forces at work in the image. Art students are expected to write generally about the forces involved, while engineering students are expected to estimate the appropriate non-dimensional

properties, such as the Reynolds number, as well as the time required and spatial resolution based on flow speed and field of view. All students are expected to cite any references, and graduate engineering students are expected to find technical, refereed literature for their references, and write at a professionally publishable level.

The course culminates in a show in the Engineering Center Lobby. Students are encouraged to submit their work to various competitions, and their work is displayed on the course website (www.colorado.edu/MCEN/flowvis/).

Prior Research:

In order to gauge student affect in the Flow Vis course, the Fluids Perception Survey (FLUPER Survey) was developed in Fall 2008. The survey design uses an item response modeling approach(38), often used in the education research community to quantitatively "summarize the responses that people make to express their achievements, attitudes, or personal points of view through instruments such as attitude scales, achievement tests, questionnaires, surveys and psychological scales."(3)

The survey defines a characteristic, "appreciation of fluid flow" and defined a continuum on which an individual's responses could be mapped. The survey was administered and refined over several semesters. Validation results were published in 2012(7). The survey offers statements such as "Visualizations of fluid flow are very beautiful" and "the study of fluids is useful to me as an engineer," to which students answer on a five point scale of agreement.

As a control during this work, students from the Fluid Mechanics course, as well as an elective, Sustainable Energy, were also surveyed. One interesting result is that there was no negative shift in affect associated with Sustainable Energy, which like Flow Vis, is an elective. However, the shift did not prove to be statistically significant in this course, unlike the results for Flow Vis. We believe that, because students select electives, they are more inclined to like or appreciate the topics. We term this the *elective effect.*

Methods:

Currently, Professor Hertzberg administers the FLUPER survey at the beginning and the end of each semester for Flow Visualization as well as Fluid Mechanics. I will continue to gather and analyze these data.

In addition, this research begins three new methods of investigation. First, interviews will be conducted with students from both Flow Vis and the Fluid Mechanics course (also taught by Professor Hertzberg), both at the beginning and at the end of the semester. These interviews are conversational in tone, and ask open-ended questions about the students' expectations for the course, their experiences both in the course and with other students. The coding scheme will be emergent, and much of what will be learned via the interviews will come through comparing early-semester and end-of-semester interviews with the same participants. As noted in the introduction, the culture of the classroom and the pedagogical techniques are of interest as possible influences of the positive shift in affect. We believe these interviews will reveal what aspects we should investigate further.

Second, students' images and written work will be analyzed, to track their improvement during the semester. Their progress through the six assignments may reveal how visual expertise or aesthetic sense is developing over time.

Third, this research will also test the hypothesis that the students increase their visual expertise while in Flow Vis, and that this visual expertise, namely seeing fluid phenomena in everyday life, is part of what improves their positive affect during the course. Using an experiment design common in experimental psychology, this research builds on the work of Professor Tim Curran (39) of the CU Psychology Department. While existing research has measured visual expertise in identifying species of birds or dogs (40), cars (41) or human faces (42), this study requires the identification of abstract concepts. With Professor Curran's collaboration, this research will start by establishing what is meant by visual expertise of fluid phenomena. The first experiment will have two groups of subjects (non-engineering students). One group will learn the difference between laminar and turbulent by doing a sorting task with a series of Kármán vortex street images. The subjects in this group will not be given instruction, but will only learn through trial and error, also called error-driven learning. The other group will be given exposure to the same

number of images during an instruction video. Both groups will be given a sorting task at the end to determine which group gained the greater expertise. Several iterations of the visual expertise experiment may be necessary to establish a baseline for visual expertise, from which we can continue to develop and refine what helps people acquire that expertise and explore the connection between visual expertise and a positive shift in affect among students.

Team:

During this research project, I look forward to developing a constructive working relationship with Professor Hertzberg. In the short since I joined her project (November 2013), we have made a strong beginning. She values my existing expertise, and I am learning about research design, among other things, from her. Due to our collaboration with other departments, I foresee working with Professor Tim Curran in Psychology, as well as Professor Noah Finkelstein in Physics.

There is also an opportunity for my mentorship of another student. Brisa Garcia Gonzalez is a mechanical engineering major already assisted with data collect for this project. I anticipate that we will work closely together.

Timeline:

Ongoing: Collection of FLUPER surveys, collection of student work; interviews with students. (IRB approval has already been obtained for this work)

*Spring /Summer 2014:*Finalize study design for visual expertise pilot; request IRB approval for that study. Run first iteration of the visual expertise study. Develop coding schema for interviews and student work.

Fall 2014: Run additional iterations of the visual expertise study (as needed). Analysis of visual expertise studies. Complete analysis of interviews, coursework, and FLUPER surveys.

Spring/Summer 2015: Present findings at the American Society For Engineering Education (ASEE) annual summer conference (submitted in early January), on campus for groups such as the Engineering Education Research group (EER) and the Discipline-based Education Research Group (DBER).

Project Outcomes:

Personal Outcomes: As a graduate student, I will be laying the foundation for my dissertation work through this project. My current research direction requires that I learn about student outcomes and affect, both from the perspective of specific courses and looking at their experience in their majors overall. I hope to use the work outlined here for the classroom perspective.

Department and College Outcomes: The immediate benefit to the Mechanical Engineering Department and to the College of Engineering is a set of tools with which to gauge the impact of technical electives. Eventually, we foresee the development of a model for additional courses, which, like Flow Visualization, fit the College's goal of providing more active learning experiences by 2020(43).

Other Departments and the CU Community: Our study of visual expertise as related to abstract concepts may further the work currently being done in the psychology department. In addition, instructors in other fields, such as physics, which rely heavily on abstract concepts, often explained through analogy, may find the tools developed from Flow Vis to be readily adapted for their uses. We will make every effort to share our findings across campus.

Specifically, we see the development of interdisciplinary courses like Flow Vis as aligning with the 5th Flagship Initiative from the 2030 Strategic Plan for CU: *transcending traditional academic boundaries*. The model we hope to develop will assist us in locating other opportunities to provide cross-disciplinary opportunities in the future.

References:

1. Sawtelle V, Brewe E, Kramer L. Validation study of the Colorado Learning Attitudes about Science Survey at a Hispanic-serving institution. Physical Review Special Topics - Physics Education Research. 2009.

2. Moll R, Milner-Bolotin M. The effect of interactive lecture experiments on student academic achievement and attitudes towards physics. Can J Phys. 2009 Aug;87(8):917–24.

3. Adams W, Perkins K, Podolefsky N, Dubson M, Finkelstein N, Wieman C. New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. Physical Review Special Topics - Physics Education Research. 2006.

4. Barbera J, Adams W, Wieman C, Perkins K. Modifying and validating the Colorado Learning Attitudes about Science Survey for use in chemistry. J Chem Educ. 2008 Oct;85(10):1435–9.

5. Brewe E, Kramer L, O'Brien G. Modeling instruction: Positive attitudinal shifts in introductory physics measured with CLASS. Physical Review Special Topics - Physics Education Research. 2009.

6. Sahin M. Effects of Problem-Based Learning on University Students' Epistemological Beliefs About Physics and Physics Learning and Conceptual Understanding of Newtonian Mechanics. J Sci Educ Technol. 2010 Jun;19(3):266–75.

7. Hertzberg J, Leppek BR, Gray KE. Art for the Sake of Improving Attitudes towards Engineering. American Society for Engineering Education. 2012.

8. Li Q, Swaminathan H, Tang J. Development of a classification system for engineering student characteristics affecting college enrollment and retention. J Eng … [Internet]. 2009 [cited 2014 Mar 14]; Available from: http://onlinelibrary.wiley.com/doi/10.1002/j.2168-9830.2009.tb01033.x/abstract

9. Rodriguez J, Choudhury A, Rodriguez L. Applying design process to redesign a personal care product- Integration of technical and marketing issues. 2010 ASEE Annual Conference and Exposition, June 20, 2010 - June 23, 2010. Louisville, KY, United states: American Society for Engineering Education; 2010.

10. Moon KS. Design-oriented structural engineering education. 19th Analysis and Computation Specialty Conference, May 12, 2010 - May 15, 2010. Orlando, FL, United states: American Society of Civil Engineers; 2010. p. 387–95.

11. Goncher A, Johri A, Sharma A. Work in progress - Use-value and functionality versus aesthetics and experience: Inculcation of design ideologies in engineering and industrial design students. 40th Annual Frontiers in Education Conference: Celebrating Forty Years of Innovation, FIE 2010, October 27, 2010 - October 30, 2010. Arlington, VA, United states: Institute of Electrical and Electronics Engineers Inc.; 2010. p. T4H1–T4H3.

12. Brezing AN, Lower M. Engineering and industrial design-an integrated interdisciplinary design theory. 2008 ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, DETC 2008, August 3, 2008 - August 6, 2008. New York City, NY, United states: ASME; 2009. p. 351–7.

13. French MJ. Engineering design in education. Electron Power [Internet]. 1980 [cited 2014 Mar 25];26(8):641–2. Available from: http://digital-library.theiet.org/content/journals/10.1049/ep.1980.0341

14. Dennis D, Al-Obaidi J. Vanguard, laggard or relic? The possible futures of higher education after the Epistemic Revolution. First Monday. 2010 Mar;15(3):13 pp.

15. Miyata K, Umemoto K, Higuchi T. An educational framework for creating VR application through groupwork. Langford Lane, Kidlington, Oxford, OX5 1GB, United Kingdom: Elsevier Ltd; 2010. p. 811–9.

16. Huang W, Eades P, Seok-Hee Hong, Chun-Cheng Lin. Improving Force-directed Graph Drawings by Making Compromises Between Aesthetics. 2010 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC 2010), 21-25 Sept 2010. Los Alamitos, CA, USA: IEEE Computer Society; 2010. p. 176–83.

17. Moss GA, Gunn RW. Gender differences in website production and preference aesthetics: preliminary implications for ICT in education and beyond. Behav Inf Technol. 2009 Oct;28(5):447–60.

18. Freudenthal E, Roy MK, Ogrey A, Gates A. A creatively engaging introductory course in computer science that gently motivates exploration of mathematical concepts. 2009 ASEE Annual Conference and Exposition, June 14, 2009 - June 17, 2009. Austin, TX, United states: American Society for Engineering Education; 2009. p. BOEING.

19. Ilmberger W, Schrepp M, Held T. Cognitive processes causing the relationship between aesthetics and usability. 4th Symposium of the Workgroup Human-Computer Interaction and Usability Engineering of the Austrian Computer Society, USAB 2008, November 20, 2008 - November 21, 2008. Graz, Austria: Springer Verlag; 2008. p. 43–54.

20. Frei J, Alvarez S, Alexander M. Ways of Seeing: Using the Visual Arts in Nursing Education. J Nurs Educ. 2010 Dec;49(12):672–6.

21. Zheng G, Zhang L, Xiao X, Gao R. Analysis of the qualities and abilities normal university students majoring in mathematics should posses under "New Curriculum Standard."2010 2nd International Conference on Industrial Mechatronics and Automation, ICIMA 2010, May 30, 2010 - May 31, 2010. Wuhan, China: IEEE Computer Society; 2010. p. 581–3.

22. Franklin C, Johnson G. Disrupting the taken for granted: Exploring urban teacher candidate experiences in aesthetic education. Think Ski Creat. 2010;5(2):83–96.

23. Chen Su. Modelling of metamorphoses teaching research. 2010 IEEE 11th International Conference on Computer-Aided Industrial Design & Conceptual Design (CAIDCD 2010), 17-19 Nov 2010. Piscataway, NJ, USA: IEEE; 2010. p. 44–6.

24. Allan J. The inclusive teacher educator: spaces for civic engagement. DISCOURSE-STUDIES Cult Polit Educ. 2010;31(4):411–22.

25. Ware C. Visual thinking: For design [Internet]. First Edit. Morgan Kaufmann; 2010 [cited 2014 Mar 25]. Available from: http://books.google.com/books?hl=en&lr=&id=WBlUgKhMbdsC&oi=fnd&pg=PP2&dq=Visual+Thinking:+for+Design&ots=U0-wCSlyp_&sig=6JuLzLLSZbkbpGZdOJYS1M6W6QE

26. Livingstone MS. Vision and Art: The Biology of Seeing. Abrams; 2008.

27. Arnheim R. Art and Visual Perception: A Psychology of the Creative Eye. 1st ed. University of California Press; 2004.

28. Solso RL. Cognition and the Visual Arts. The MIT Press; 1996.

29. Zeki S. Inner Vision: An Exploration of Art and the Brain. Oxford University Press, USA; 2000.

30. Frankel F. Envisioning Science: The Design and Craft of the Science Image. The MIT Press; 2004.

31. Tufte ER. Visual Explanations: Images and Quantities, Evidence and Narrative. First Edit. Graphics Press; 1997.

32. Tufte E, Graves-Morris P. The visual display of quantitative information [Internet]. Graphics Press; 1983 [cited 2014 Mar 25]. Available from: http://www.eng.auburn.edu/users/fmm0002/DVsyllabus.pdf

33. Tufte E. Envisioning information. Optom Vis Sci [Internet]. 4th Printi. Graphics Press; 1991 May [cited 2014 Mar 25]; Available from: http://journals.lww.com/optvissci/Abstract/1991/04000/Envisioning_Information.13.aspx

34. Loverude M, Heron P, Kautz C. Identifying and addressing student difficulties with hydrostatic pressure. Am J Phys. 2010 Jan;78(1):75–85.

35. Rosengrant D, Van Heuvelen A, Etkina E. Do students use and understand free-body diagrams? Phys Rev Spec Top Educ Res. 2009 Jun;5(1).

36. Reiner M. Sensory Cues, Visualization and Physics Learning. Int J Sci Educ. 2009;31(3):343–64.

37. Kohl P, Rosengrant D, Finkelstein N. Strongly and weakly directed approaches to teaching multiple representation use in physics. Phys Rev Spec Top Educ Res. 2007 Jun;3(1).

38. Wilson M. Constructing Measures: An Item Response Modeling Approach. Mahweh, NJ: Lawrence Erlbaum Associates; 2005.

39. Tanaka J, Curran T. A neural basis for expert object recognition. Psychol Sci [Internet]. 2001 Jan [cited 2014 Apr 1];12(1):43–7. Available from: http://pss.sagepub.com/content/12/1/43.short

40. Tanaka J, Taylor M. Object categories and expertise: Is the basic level in the eye of the beholder? Cogn Psychol [Internet]. 1991 [cited 2014 Apr 1];23(3):457–82. Available from: http://www.sciencedirect.com/science/article/pii/001002859190016H

41. Gauthier I, Skudlarski P, Gore JC, Anderson a W. Expertise for cars and birds recruits brain areas involved in face recognition. Nat Neurosci [Internet]. 2000 Feb;3(2):191–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10649576

42. Gauthier I, Curran T, Curby K, Collins D. Perceptual interference supports a non-modular account of face processing. Nat Neurosci. 2003 Apr;6(4):428–32.

43. A FRESH LOOK AT Vision for Excellence Engineering 2020 : [Internet]. Boulder, CO; 2014. Available from: http://www.colorado.edu/engineering/sites/default/files/Engineering_2020.pdf

Katherine A. Goodman April 2014
5137 S. Ceylon Ct (303) 514-6198
Centennial, CO 80015 katherine.goodman@colorado.edu

Education:

Doctor of Philosophy, (projected December 2016)
ATLAS Institute, College of Engineering, University of Colorado, Boulder, CO\
(GPA as of 12/2013 : 4.0/4.0)
Research interests: engineering education, flipped classrooms, Open Education Resources (OER), Massive Open Online Courses (MOOCs)
Recent Coursework: Current Topics in Comp Science: Big Data; Education Seminar in Human Learning; Advanced Special Topics: Xbox Game Design; Teach & Learn Physics; Computational Cognitive Neuroscience

Master of Professional Writing, University of Southern California, Los Angeles CA; May 2002
Emphasis: Fiction, (GPA: 3.9/4.0)
Thesis: *The Master Key and Other Stories*
Honors: Phi Kappa Phi Award for *Selected Poems*, 2002

Bachelor of Science, Valparaiso University, Valparaiso IN; May 1997
Majors: Mathematics; Languages and Literature , (GPA 3.9/4.0)
Honors Thesis: "In Defense of an Onion: the Life of Active Love as Presented in Dostoevsky's *The Brothers Karamazov*"

Research Experience:

Research Assistant, University of Colorado; Boulder, CO Present
Member of engineering education research team

Research Assistant, Los Alamos National Laboratory; Los Alamos, NM; Jan -Aug 96
Member of linguistics research team responsible for:
Writing procedures & revising grant proposals
Manipulating audio data
Demonstrating work to National Science Foundation & Department of Energy officials

Independent Mathematics Researcher, Valparaiso University, Valparaiso, IN; May-Aug 95
Awarded grant from Council for Undergraduate Research
Discovered & proved original theorems in Graph Theory

Teaching Experience:

Adjunct Faculty, Community College of Aurora, Aurora, CO; 2009-12
Taught Composition I and II to students widely diverse in age, background, and native language
Consistently received higher than average student evaluation feedback

Private Tutor, various locations, dates
One-on-one sessions with students, ranging in ages from seven to nineteen
Subjects tutored include mathematics (arithmetic, Algebra, Geometry, Algebra II, Calculus), English, writing, writing to ESL students
Consistently improved students' skills, received high marks on all evaluations

Assistant Lecturer, University of Southern California, Los Angeles, CA; 2000-02
Taught from program curriculum to college freshman as an instructor of record
Created & implemented original lessons & assignments, coordinated with a social issues course

Undergraduate Teaching Assistant, Valparaiso University
For Math Dept: ran Calculus I computer lab & assisted group work in a problem-solving course
For Humanities course: Led weekly discussion of interdisciplinary texts & graded weekly writing assignments

Other Professional Experience:

Contract Technical & Procedural Writer, Various companies
Worked onsite for clients including *American Honda Motor Corporation, the Society of Children's Book Writers and Illustrators,* and *the Los Angeles Community College District*
Wrote a wide range of materials: computer-based training storyboards, online helps, customized manuals, customer correspondence, and specifications for internal workflow software

Project Manager & Curriculum Designer, SoftWorks Corporate Training, Long Beach, CA; 1999-2000
Managed multiple instructor-led training projects
Customized courseware, including manuals, quick reference guides, & skills assessments
Developed original storyboards & scripts for Computer Based Training (CBTs)

Technical Writer, J. D. Edwards World Source Company, Denver, CO; Oct 97 - Mar 99.
Member of software development team who documented OneWorld installation & upgrade procedures for AS/400, Windows NT, & UNIX systems (800+ pages of material)
Managed content from programmers to writers
Trained new writers
Assisted in software testing

Academic Publications:

Goodman, Katherine and Bennett, John K. "Modeling the Serial Position Effect: Using the Emergent Neural Network Simulation System" BIOINFORMATICS 2014 Proceedings, March 2014.

Dueringer, Katherine. "Homomorphic Images of Paths and Homomorphism Polynomials" 10th Annual National Conference for Undergraduate Research Proceedings, Spring 1996.

Some work completed under the Katherine (or Kate) Dueringer.

Student's Full Name
Katherine Goodman

Adviser's Full Name
Jean Hertzberg

Adviser's Home Department
Mechanical Engineering

Adviser's Email Address
hertzberg@colorado.edu

By submitting this application, I confirm that, if my advisee is selected to receive a Chancellor's Award for Excellence in STEM Education, I will:

- ✓ Attain a GRA salary match (25% during the academic year, and 50% during the summer) from my own funding sources or from my department.
- ✓ Attend the annual Symposium on STEM Education (fall 2014).
- ✓ Actively engage in the CU-Boulder STEM education community by attending the weekly DBER Seminar Series when possible.

Graduate Chancellor's Award for Excellence in STEM Education

Advisor Statement of Support

Student: Katherine Ann Goodman

Advisor: Jean Hertzberg

Mechanical Engineering

Hertzberg@colorado.edu

Mentoring Description

I am planning on being flexible in working with Kate Goodman, for several reasons: 1) She is a nontraditional student, and comes in with a wonderfully diverse background and a mature perspective. 2) Kate is in the ATLAS PhD program. This is a relatively new interdisciplinary program, and since ATLAS has a brand new director, I expect that some aspects of the PhD program may change. 3) Kate began working with me in November, after she had invested close to a year defining a thesis direction with John Bennett as her advisor. She is still interested in pursuing that direction, but is also committed to the Flow Visualization project and we periodically discuss how the two directions are related, how to best synthesize the work she is doing on multiple fronts, and how to manage time and effort. I'm happy to report that we are making good progress. Kate is highly motivated to complete her degree in a timely fashion; based on her productivity so far I am confident that she will do so.

We have weekly one-hour meetings together with an undergraduate research assistant, Brisa Garcia-Gonzales. The meetings loosely follow a management-by-objectives approach: what was done last week, what are Kate's and Brisa's goals for the next week, and what can I (as advisor and resource provider) assist the two of them with?

Departmental mechanisms for including the results of the research in the student's degree program

The ATLAS degree program is ideally suited to this interdisciplinary work. In contrast to the usual difficulties of DBER students, all of Kate's courses and all of the planned research will contribute directly towards her degree requirements, and she will still have a degree from the College of Engineering.

One of the ATLAS program requirements is that students produce published work. This fits well with my philosophy on theses; that the thesis should be structured around journal publications. Kate has been willing and able to document her work from the very start, with both conference papers and presentations. For example, she recently presented her research plan at both the Engineering Education Research Group meeting and at DBER.

Kate's choice of courses here at CU have been ideal preparation for work on this project, encompassing quantitative and qualitative research methods in education and neuropsychology. The fit with both the ATLAS program requirements and the demands of our project cannot be improved on. I had been

looking for a student for this project for a year, and my optimism was flagging when Kate answered my position announcement. I've been absolutely delighted with her preparation and contributions.

Matching funds

Matching funds will come from my NSF Research Initiation in Engineering Education grant: EEC-1240294, "The Power of Aesthetics" NSF RIGEE program. Hertzberg PI, Curran, Finkelstein, Ito Co-PIs. 01/01/2013 - 12/31/2014, $150,000. This grant has 50% AY, 100% summer support for one grad student for two years. With an appropriate no-cost extension, this will guarantee a year's worth of matching. In fact, I expect this award to allow Kate to complete her thesis.

How the proposed project will further your development, support STEM education within the home department, and benefit the CU-Boulder community as a whole

I secured the NSF RIGEE award for studying the impact of Flow Visualization and aesthetics on students after no less than eight rejected submissions. It is my first funded engineering education research (EER) project and I hope the first of many. I have invested a significant portion of my research time over the past eight years in learning this new field because I feel that improving our engineering students' educational experience is vitally important to my department, college, campus and to society as a whole, and I feel that I can make a unique contribution. This award will enable Kate and I and our collaborators to complete enough work to make a strong case for a larger research program.

Engineering education research has an uphill battle ahead of it in my department and in the College of Engineering. Several of my colleagues have expressed skepticism that education research belongs in our college at all. This award program can send an important message to the contrary, that EER does belong in our college, and that proponents of EER are not alone or without resources, and that our work has merited the support of the Chancellor.

Giving the Chancellor's Graduate Award to Kate Goodman will have an additional benefit to Kate's home program in ATLAS. Students in her program have always been encouraged to seek support from outside sources, but Kate reports that she is the first student she knows of to have succeeded. ATLAS recently moved into the College of Engineering, and this award could provide additional encouragement to her peers to integrate with the College.

I also want to acknowledge early support for this project from the President's Teaching and Learning Collaborative. I hope this project can serve as an example of how such seed efforts can grow and blossom.

In addition to these somewhat political considerations, our work on how aesthetics and visual expertise can influence students' affect is expected to have wide-ranging implications. The idea that students may be attracted to engineering (specifically mechanical engineering) not for its importance, utility or even benefit to society but because some aspects are not just cool, but *beautiful* is quite novel. Exploitation of this idea may help solve long-standing problems in the recruitment and retention of a diverse student population and workforce.

Curriculum Vitae

Jean R. Hertzberg

Associate Professor

Department of Mechanical Engineering

University of Colorado

Boulder, CO 80309-0427

Phone: (303)492-5092

Fax: (303)492-2863

E-mail: Hertzberg@Colorado.edu

Web Page: http://stripe.colorado.edu/~hertzber/

January 2014

Education

Ph. D., Mechanical Engineering, University of California, Berkeley, December 1986.

M. S., Mechanical Engineering, University of California, Berkeley, June 1983.

B. S. E., Mechanical Engineering, University of Michigan, Ann Arbor, Magna Cum Laude May 1981.

Professional Experience

Associate Professor	Department of Mechanical Engineering
May 1997 - present	University of Colorado, Boulder
Assistant Professor	Department of Mechanical Engineering
Jan. 1991 - May 1997	University of Colorado, Boulder
Research Associate	Aerospace Engineering Department

Jan. 1987- Dec. 1990	University of Southern California
Research Assistant	Turbulent Combustion Group
Oct. 1981- Dec. 1986	Lawrence Berkeley Laboratory
Research Assistant	Wood Combustion Studies
May 1981- Oct. 1981	University of Washington, Seattle
Research Assistant	Heat Transfer Laboratory
May 1980- Aug. 1980	University of Michigan, Ann Arbor
Junior Engineer	Assembly Engineering Dept.
May 1979- Aug. 1979	Metal Stamping Division
	Ford Motor Company, Dearborn, MI

Professional Activities and Service

Service to Journals

Regional Editor for North America, Journal of Flow Control, Measurement and Visualization, 2012 - present

Portfolio Managing Editor, Journal of Visualization, 2006-2009. Associate Editor 2010-present.

Associate Editor, eFluids.com, 2007-.

Service to Scholarly or Professional Organizations

APS

Local Organizing Committee Chair, American Physical Society, Division of Fluid Dynamics Annual Meeting November 2017, Denver, CO.

Chair, Education and Career Outreach Committee, American Physical Society , Division of Fluid Dynamics. 11/2012- 11/2013 (Vice Chair, 11/2011 – 11/2012, founding member 2010-2011).

Founder, Organizer and CoChair, Workshops on Fluids Education, American Physical Society, Division of Fluid Dynamics, Annual Meetings 2008, 2009, 2010, 2011.

Minisymposium Organizer and Chair: “Fluids Education”, American Physical Society , Division of Fluid Dynamics, 59th Annual Meeting, Tampa Fl, 2006; “Fluids Demonstrations and Instructional Laboratories”,

American Physical Society , Division of Fluid Dynamics, 60th Annual Meeting, Salt Lake City, UT. Nov 18-20 2007; "Videos and Multimedia for Fluids Instruction", American Physical Society , Division of Fluid Dynamics, 61th Annual Meeting, San Antonio Texas. Nov 23-25, 2008

Executive Committee Member-at-Large, American Physical Society , Division of Fluid Dynamics. Elected to 3 year term, 2007 – 2010.

Publications and Media Committee, American Physical Society , Division of Fluid Dynamics. 2008.

Founded the Fluids Education Google group, made up of 197 international engineering academics, 12/2006.

Bioengineering

Founding Member, Colorado Alliance for Bioengineering (CAB), 1998-2001.

Organizer, Colorado State Fair Exhibit on Bioengineering, 2001.

Chair, CAB Day at Fitz. Organized Colorado Alliance for Bioengineering Day at Fitzsimons, a poster session that brought together over 150 members of the local bioengineering community, including faculty, staff and students from CU Boulder, Colorado State U., Colorado School of Mines and UCHSC, as well as members of the Colorado Biotechnology Association and the Colorado Biomedical Device Association. Described in the Denver Post 12/6/2000 Business section.

Co-Chair, Fluids: Experimental Techniques Session, 11th International Conference on Mechanics in Medicine and Biology, Maui, HI, April 2-5, 2000.

Other

Participated in the Third Annual Women in Engineering Roundtable, sponsored by Graduating Engineer and Computer Careers Magazine. Described in the Feb. 2000 issue, pp 18 - 23.

Co-Chair, Work-In-Progress Poster Session, 27th Symposium (International) on Combustion, Boulder, CO 1998.

Member, Organizing Committee, 27th Symposium (International) on Combustion, Boulder, CO 1998.

Member, Organizing Committee, 15th International Colloquium on the Dynamics of Explosions and Reactive Systems, Boulder, CO, 1995.

Consultant, Science Review Panel, Microgravity Combustion Program, NASA Lewis, 1993.

Chair, Organizing Committee, Sixth Office of Naval Research Propulsion Meeting, Boulder, CO, 1993.

Member, Program Review Subcommittee, Combustion Institute, International Combustion Symposium, 1992, 1994, 1996, 1998, 2000.

Reviewer of papers, proposals and programs for:

Journal of Fluid Mechanics

Physics of Fluids

Experiments in Fluids

Journal of Visualization

BioMedCentral Public Health

International Journal of Heat and Fluid Flow

Combustion and Flame

Combustion Science and Technology

International Symposium on Combustion

AIAA Journal

Journal of Heat and Fluid Flow

Journal of Propulsion and Power

Journal of Fluids Engineering

ASME Journal of Energy Resources Technology

Office of Naval Research

Army Research Office

National Science Foundation

National Aeronautics and Space Administration

Membership:

American Physical Society

American Society for Engineering Education

American Society of Mechanical Engineers

American Association of University Women

American Association of University Professors

Tau Beta Pi

Pi Tau Sigma

Honors and Awards

2010 Marinus Smith “Making a Difference” Teaching Excellence Award from the CU Boulder Parents Association.

2010 John and Mercedes Peebles Innovation in Education Award nominee (56 in CEAS).

2010 Ilya Lisenker, Jean Hertzberg, “Spinning on a Skillet.” Entry in the NSF/ Science Magazine 'International Science and Engineering Visualization Challenge'. Selected as a Finalist.

2008 Best Poster in Flow and Motion category, International Society for Magnetic Resonance in Medicine 2008 meeting.

2006, 2003 Winner, Gallery of Fluid Motion, American Physical Society Division of Fluid Dynamics Annual Meeting

2006 2nd place Combustion Art competition, Central States Section, Combustion Institute.

2006 Seven Flow Visualization course images accepted into the juried CU Art/Science exhibit

2004-2005 Mechanical Engineering Outstanding Service Award, CU Boulder

2004 New Inventor of the Year Award, CU Boulder

2004 Best Paper PIC III, ASEE Annual Meeting

1997 Honorary Member, Pi Tau Sigma, Mechanical Engineering Honor Society

1996 Associate Fellow, American Institute of Aeronautics and Astronautics

1991 National Science Foundation Research Initiation Award

1985 IBM Fellowship

1981,1982 Graduate Opportunity Fellowship, U.C. Berkeley

1979 Member of Tau Beta Pi, the National Engineering Honor Society

1976-1980 Dean's Honor List, University of Michigan

1979 Ford Fellowship

1976 Ford Freshman Scholarship

1976 Society of Women Engineers Award

Research Grants

“The CIRTL Network: Local Learning Communities at CU Boulder” Subaward from the University of Wisconsin’s NSF award “The CIRTL Network: 25 Research Universities Preparing a National Faculty to Advance STEM Undergraduate Learning” Hertzberg PI, Border Co-PI. 8/15/2013 – 7/31/2016, $160,125.

"The Power of Aesthetics" NSF RIGEE program. Hertzberg PI, Curran, Finkelstein, Ito Co-PIs. 01/01/2013 - 12/31/2014, $150,000.

“4 Dimensional Cardiac MRI for the Diagnosis and Assessment of Pulmonary Hypertension”. Butcher Seed Grant. Fenster PI, Hertzberg CoPI. 06/01/2012 – 5/31/2014, $100,000.

“4 Dimensional Cardiac MRI for the Assessment of Disease Severity and Prognosis in Pulmonary Hypertension”. National Jewish Health, Translational Research Initiative. Fenster PI, Hertzberg CoPI. 3/1/2012 – 2/28/2013. $51,844

Analysis of 4DMRI Cardiac Flow Related to Pulmonary Hypertension. National Jewish Hospital, consulting basis. 6/4/11 – 6/3/2012. $2000. Hertzberg PI.

A MEMS Pulsed Injection Electrostatic Atomizer for Small Engines. Subcontract to CU Boulder on US Army Small Business Technology Transfer (STTR)Phase II contract with TDA Inc, Proposal A2-3696. Principal Investigator: John W. Daily $250,781. Duration: 09/01/09 - 08/31/11 Co-PI: Jean Hertzberg 25% time, 3 months Summer.

Experimental Investigation of Hospital Operating Room (OR) Air Distribution. Zhai PI, Hertzberg Co-PI, ASHRAE, 1.0 month summer, $140,685. 09/1/08 – 8/31/10.

Development of a micro- and macro- particle image velocimetry system for opaque flows. Shandas PI, Hertzberg CoPI. NSF. $526,268. 08/01/04 - 07/31/07. 10% AY, 0.5 month summer.

Real time ultrasound blood flow velocimetry. Shandas PI, Hertzberg Collaborator, NIH, 1.0 month AY. Total amount: $300,000 6/1/04 - 5/31/06.

Principal Investigator, “Acquisition of a Particle Image Velocimetry System,” National Science Foundation, CTS 0114109, 11/1/2001-10/31/2003, $82,000.

Principal Investigator, “Modeling of Mitral Flow Data,” Council on Research and Creative Work, CU Boulder, 2001, $4,800.

Collaborator, “Mechanics of pulmonary hypertension”, 6/01 – 5/05, National Institutes of Health $175,000.

Co-Investigator, “REU Supplement for ITR: An Interactive Experimental/Numerical Simulation System with Applications in MEMS Design” National Science Foundation, ACI-0083004, $30,000, 9/1/2001-8/31/03.

Senior Researcher, “ITR/ACS: An Interactive Experimental/Numerical Simulation System with Applications in MEMS Design,” National Science Foundation, 2000-2003, $499,999.

Co-Investigator, “Fluid Mechanics of Ventricular Filling,” Whitaker Foundation, 1998-2001, $205,587

Principal Investigator, NASA-NAG3-1616, “Three-Dimensional Flow in a Microgravity Diffusion Flame,” 1994-1998, $400,000.

Co-Investigator, “Imaging System for Propulsion Phenomena” Office of Naval Research, 1997-1998, $160,924

Principal Investigator, ONR-N000149311305, “Combustion Control in Compact Waste Incinerators,” 1993-1996, $450,000.

Principal Investigator, ONR-N000149310118, “Combustion of High Energy Fuels,” 1992-1995, $404,432.

Principal Investigator, ONR-N000149311184, “AASERT Supplement: Optical Soot Diagnostics for High Energy Fuel Combustion,” 1993-1996, $123,787.

Principal Investigator, NSF-CTS-9109778, “Research Initiation Award: Combustion in an Asymmetric Configuration,” 1991-1993, $70,000.

Principal Investigator, NSF-CTS-9109778-01, “Research Experience for Undergraduates Supplement: Combustion in an Asymmetric Configuration,” 1991-1993, $10,000.

Co-Investigator, NSF-CTS-9111746, “Engineering Research Equipment: Laser Doppler Velocimetry System for Combustion Research,” 1991-1992, $34,192.

Student Supervision

PhD

Katherine Goodman, Aesthetics in Engineering Education. PhD Atlas program, started Fall 2013.

Miles Abarr, Synthetic Jets for Indoor Air Quality (co-advised). Began Fall 2013

Andrew Carter, Streaming Birefringence of Expanded Mica Colloid Suspension. PhD project Fall 2011 – Fall 2012

James Browning, Analysis of 4DMRI Cardiac Flow Related to Pulmonary Hypertension. PhD, began Fall 2011.

James McNeill (co-advised) “Operating Room Air Flows” PhD expected May 2014.

Natalie Ross (co-advised), “Point-Vortex Modeling of a Forced Planar Jet,” PhD May 2008.

Rui Wang, (co-advised) “Right Ventricular Assist Device for Fontan Patients: Pump Design, Fabrication and Assessment,” December 2007.

Lingli Liu (co-advised), “Fabrication of Capacitative Micromachined Ultrasonic Transducers,” December 2007.

Hairong Zheng (co-advised), “Effect of Ultrasonic Waveform on Nonlinear Microbubble Response”, May 2006.

Rick Luebs, “Cardiovascular Imaging,” PhD project Jan-Oct 2005.

John Carlton, “Three-Dimensional Flow in a Microgravity Diffusion Flame,” Ph.D. August 2004.

Craig Weinberg (co-advised), “Noninvasive Measurement of Pulmonary Vascular Resistance in Pediatric Pumonary Hypertension,” Ph.D. student, co-advised by Robin Shandas, May 2003

Kevin Anderson (co-advised), “Simulation of Non-Premixed Actively Forced Reacting Vortical Structures Within a Confined Domain” Ph.D. student, co-advised by Shankar Mahalingam, May 1998.

Rom McGuffin (co-advised), “Combustion Instability in a Ramjet,” Ph.D. student, co-advised by John Daily, December 1996.

Tae Chang, “Interaction between an Asymmetric Vortex Ring and a Wall,” Ph.D. December 1994.

Masters

Vigneshwaran Selvaraju, “High Voltage Augmentation of Fuel Sprays” started Fall 2013.

Brett McQuillan “Synthetic Jets for Indoor Air Quality” M.S. thesis, Fall 2013. Co-advised by Lupita Montoya.

Luis Loma “Flow in a Compliant Model Aorta,” M.S. thesis May 2010.

Logan Williams, (co-advised) “Micro Echo PIV,” M.S. thesis December 2008.

Paul Miller, “Flow in a Model Aorta,” M.S. thesis May 2007.

Meg Van Sciver, “Flow Field Measurements of Human Generated Infectious Aerosols,” M.S. Thesis, May 2005.

Andrew Shugard, “Emissions Measurement in a Split Diffusion Flame,” M.S. project 2004.

Heather Chluda, “Vorticity Analysis of Left Ventricular MRI Data”, Sept 2003- May 2004. MS project.

John Giardino, “Stereomicroscopic Particle Image velocimetry” MS Thesis, co-advised with E. Bradley. Completed May 2004.

Josh Madsen, “Emissions Measurement in a Split Diffusion Flame,” M.S. project 2003.

Aravind Pittyvasanthankar, “Streamwise Vorticity Measurements in a Jet,” M.S. project May 2004.

Bethany Rotherham, “Testing of Fin Designs for Air Cooled Condensers,” M.S. project Fall 2002.

Evan Collier, “Modeling of Mitral Flow Data,” MS Thesis, May 2001-May 2002.

Jason Cooke, “Fluid Dynamics of Ventricular Filling,” MS Thesis, May 2001.

Eric Marquardt, “Compact Heat Exchanger Design,” M.S. thesis, May 2002.

Edward Poulin, “Design of the Model Ramjet Automatic Control System,” M.S. 1995

Devireddy Ramachandra, “Numerical Simulation of Vortex/Wall Interactions,” M.S. thesis May 1995.

Margaret Thames, “Seeding of Low Velocity Flows,” M.S. thesis 1995.

Brian Heiler, “High Energy Fuel Combustion,” M.S. May 1994.

Matt Cuddy, “Forced Laminar Diffusion Flame,” M.S. May 1994.

Patrick Zmarzly, “Velocity Measurements in an Electric Field Enhanced Outside Vapor Deposition Flame,” M.S. December 1993.

Suzy Till, National Science Foundation GK-12 Fellow, 1999-2000.

Frank Friedl, National Science Foundation GK-12 Fellow, 2000-2001

Service on MS and PhD thesis committees for an additional 55 students.

Supervised undergraduate involvement in research via independent study and UROP/URAP for 150 students.

Summary of Courses Taught

Course	Semester	Enrollment
MCEN 1020/GEEN 1300 Computational and Analytic Tools: Lecture and laboratory	F 91	97
	F 92	88
	F 93	98
	F 94	94
GEEN 1400 First Year Projects: Lecture and laboratory	F97	30
	F98	29
	F99	23
	F01	28
	S04	30
	S08	30
MCEN 3012 Thermodynamics I: Lecture	F01	102
	F02	98

	F03	160
	F05	130
MCEN 3021 Fluid Mechanics: Lecture	F 95	82
	F 96	70
	F 07	175
	F 08	145
	F 09	128
	F 10	129
	F 11	64
	F 12	120
	S 14	80
MCEN 3022 Heat Transfer	S99	84
MCEN 3027 Measurements Laboratory: Lecture and laboratory	S 92	41
	S 93	54
	S 94	48
	S 95	46
	S 96	38
	F 97	10
	F 98	24
	F 99	37
	S 01	47
MCEN 3030 Numerical Methods: Lecture	S 93	83
	S 94	94
	S 97	54
	S 98	53
MCEN 3032 Thermodynamics 2	S 12	60
	F 12	14

	F 13	63
MCEN 4027 Senior Laboratory: Lecture and laboratory	S 91	23
MCEN 4151/5151 Flow Visualization: The Physics and Art of Fluid Flow. Co-taught as FINE 4097/5097, now crosslisted as FILM 4200/ARTS 5200. New course development.	S03	42
	F04	25
	S06	25
	F07	35
	S 09	33
	S 10	30
	S 11	45
	S 12	50
	S 13	65
	S14	48
MCEN 4228 Undergraduate Research Seminar in Combustion. New course development	S 95	9
MCEN 4228/5248 Special Topic: Digital Data Acquisition. New course development	S99	14
MCEN 4228/5228 Special Topic: Perception of Design	F 09	30
New course development	F 10	21
	F 11	23
MCEN 5021 Fluid Mechanics: Lecture	F 96	12
MCEN 5022 Thermodynamics: Lecture	S02	16
MCEN 5228 (Team taught) Special Topics in Combustion Theory	F 93	5
MCEN 5258 (Team taught) Special Topics in Combustion Science and Applications	F 92	11
MCEN 6278 Fluid Mechanics Measurements. New course development.	S 98	5

University Service

Campus

Developed and presented the first STRIPE workshop: Summer Teaching as Research Institute for Postdocs in Engineering. August 12-23, 2013. 20 hour workshop for 10 STEM postdocs from across the campus on teaching techniques.

Institutional Leader for the Center for the Integration of Research, Teaching and Learning (CIRTL), a nationwide network of institutions committed to advancing the teaching of STEM disciplines in higher education. 2012 – present

Faculty Teaching Excellence Program as Faculty Associate 2008-

Campus representative to, and founding member of the Colorado Alliance on Bioengineering, 1998-2002

College

Co-Organizer for the First and Second CEAS Education Retreats. Duties included setting agenda, publicity, selecting venue, food and staffing.

College Undergraduate Education Council, 2002-2006, 2008-

College Humanities and Social Science Committee, 2005-2006

College Committee on Bioengineering, Chair, 1998-2002

College Computer Resources Committee, 1994-1995.

College Freshman Computer Course Committee, 1993-1994.

College Diversity Retreat participant, 1994.

College Special Opportunity Search Committee, 1992.

ITLL Faculty Advisory Council 2006

ITLL Thermodynamics and Heat Transfer Focus Group 1997-2000

ITLL Measurements Focus Group, 1995.

ITLL High Performance Computing Focus Group, 1994.

Department

Mechanical Engineering Assessment and Curriculum Subcommittee Member 2012- present

Mechanical Engineering Assessment and Curriculum Subcommittee Chair 2009-2011.

Mechanical Engineering ABET Committee Chair, 2004-2005.

Mechanical Engineering Undergraduate Committee Chair, 2002-2006, 2008-2009

Mechanical Engineering Executive Committee 2002-2006, 2007-2011

Mechanical Engineering Undergraduate Committee, 1994-1996, 2001-2002.

Mechanical Engineering Industrial Relations Committee, 1996-1998,2001.

Mechanical Engineering Ad Hoc Space Committee, 1997-1998.

Mechanical Engineering Ad Hoc Laboratory Committee, 1991-1996.

Mechanical Engineering Graduate Committee, 1991-1992.

Mechanical Engineering Facilities Committee, 1992-1994.

Undergraduate Initiative Fund Department Administrator, 1994-present.

ME Department Computer Network Administrator, 1993-1998.

ME Women's Network Facilitator, 1993-2002.

Implemented the "Teamwork and Leadership Program" for M.E. freshmen, 1992-1994.

Faculty Advisor for Pi Tau Sigma (Mechanical Engineering Honor Society), 1994-present.

Panelist for the Faculty Teaching Excellence Program, 1993.

Colorado Space Grant Consortium Reviewer, 1994.

Engineering Outreach Programs

Expanding Your Horizons, 1992, 1994, 1995-1999, 2003-2006, 2008- present.

"Forces In Fluids" Author and presenter, 2 day K4-12 school teachers workshop, in conjunction with the ITLL and TeachEngineering.com workshop series, July 12-13, 2007.

"Forces In Fluids" Author and presenter, 3 hour high school teachers workshop, in conjunction with the APS Division of Fluid Dynamics annual meeting, 2006.

"Floating and Falling Flows" NSDL TeachEngineering.com activity module, 2006.

"Density Rainbow and the Great Viscosity Race" NSDL TeachEngineering.com activity module, 2006.

CU Wizards Shows "Too Hot To Handle", 10/03, 9/05. "Go with the Flow" 9/04.

"Shock Your Socks Off". K-12 Teacher Workshop 2002.

"Kinetics For Kids". K-12 Physics Teacher Workshop, 1999, 2001.

Women in Engineering Career Day, 1994,1996-1998, 2003, 2005.

WIEP Energy Education Workshop 1999.

Engineering Open House, 1991, 1992, 1994.

Engineering Orientation, 1993, 1998, 1999-2005.

Engineering Career Day, 1993, 1994.

High School Honors Institute, 1993, 2006.

Judge, California State Science Fair, 1988.

Judge, Boulder Valley Regional Science Fair, 2002.

Archival Publications

J. Hertzberg, M. Namazian and L. Talbot, "A Laser Tomographic Study of the Interaction of a Flame and a Karman Vortex Street," *Combustion, Science and Technology*, **38**, pp.205-216,1984.

P. Cho, C.K. Law, J. Hertzberg and R. Cheng " Structure and Propagation of Turbulent Premixed Flames Stabilized in a Stagnation Flow," *Twenty First Symposium (International) on Combustion*, Combustion Institute, 1986.

I.G. Shepherd, J.R. Hertzberg, L. Talbot, "Flame Holding in Unconfined Turbulent Premixed Flames." Paper presented at ICASE Workshop on Supersonic Combustion, NASA Langley, VA, Oct. 1989. Later published in *Major Research Topics in Combustion,* M.Y. Hussaini, A. Kumar, R.G. Voight, Editors. Springer-Verlag, New York, 1992.

J. Hertzberg, I. Shepherd, L. Talbot, "Vortex Shedding Behind Rod Stabilized Flames," *Combustion and Flame*, **86**, pp. 1-11, 1990.

J. Hertzberg and C.M. Ho, "Time-Averaged Three-Dimensional Flow in a Rectangular Sudden Expansion," *AIAA Journal*, **30** (10), pp. 2420-2425, errata **30**(11), pp. 2803, 1992.

J. Hertzberg and C.M. Ho, "Vortex Dynamics in a Rectangular Sudden Expansion," *Journal of Fluid Mechanics,* **289**, pp. 1-27, 1995.

K. Anderson, J. Hertzberg and S. Mahalingam, "Classification of Absolute and Convective Instabilities in a Bluff Body Stabilized Flame," *Combustion Science and Technology* **116**, pp. 257-269, 1996.

T.Y. Chang, J. Hertzberg, R. Kerr, "Three-Dimensional Vortex Wall Interaction: Entrainment in Numerical Simulation and Experiment," *Physics of Fluids* **9** (1) pp. 57-66, January 1997.

J. Hertzberg, “Conditions for a Split Diffusion Flame,” *Combustion and Flame,* Vol. 109, pp 314-322, 1997.

J. Hertzberg, J. Carlton, E. Davis, M. Linne, “Splitting of Forced Elliptic Jets and Flames,” *Journal of Image Processing and Flow Visualization*, Vol. 5, pp.155-165, 1998.

J.D. Luff, A.M. Rompage, M.A. Linne and J.R. Hertzberg, “Experimental Uncertainties Associated with Post-Processing of Particle Image Velocimetry (PIV) Based Algorithms,” *Experiments in Fluids*, **26**, pp. 36-54, 1999.

K. R. Anderson, S. Mahalingam and J. Hertzberg, “A Two-Dimensional Planar Computational Investigation of Flame Broadening in Confined Non-Premixed Jets,”

Combustion and Flame, **118**, pp. 233-247, 1999.

C.G. DeGroff, S. Bhatikar, J. Hertzberg, R. Shandas, L. Valdes-Cruz, R. Mahajan. Use of artificial neural networks to discriminate between innocent and pathological murmurs. http://circ.ahajournals.org/cgi/content/abstract/103/22/2711. *Circulation*, **103**(22), pp. 2711, 2000.

R. Shandas, C. Weinberg, E. Nicol, D.D. Ivy, C. DeGroff, J. Hertzberg, L.M. Valdes-Cruz. “Development Of A Non-Invasive Ultrasound Color M-Mode Means Of Estimating Pulmonary Vascular Resistance In Pediatric Pulmonary Hypertension: Numerical Analysis”, *In vitro* Validation and Preliminary Clinical Studies, *Circulation*, **104**, pp. 908-913, 2001.

C. Weinberg, J. R. Hertzberg, R. Shandas “Utility of Intravascular Ultrasound to Measure Local Compliance of the Pediatric Pulmonary Artery: In Vitro Studies” *Journal of the American Society of Echocardiography* **15** (12) pp. 1507-1514, 2002.

J. Cooke, J.R. Hertzberg, M. Boardman, R. Shandas, “Characterizing Vortex Ring Behavior During Ventricular Filling with Doppler Echocardiography: An In Vitro Study” *Annals of Biomedical Engineering.* **32**(2), pp. 245-256, 2004.

T. Peacock, E. Bradley, J. Hertzberg, Y.C. Lee, “Forcing a planar jet flow using MEMS,” *Experiments in Fluids*, Vol. 37(1), pp. 22-28, 2004.

Zichun Ma, Elizabeth Bradley, Thomas Peacock, Jean R Hertzberg, Yung-Cheng Lee, "Solder-Assembled Large MEMS Flaps for Fluid Mixing" IEEE Transactions on Advanced Packaging, Vol 26, no. 3, August 2003, pp 268-276.

H.-B. Kim, J. R. Hertzberg and R. Shandas, "Development and Validation of Echo PIV", *Experiments in Fluids,* ISSN:0723-4864, DOI: 10.1007/s00348-003-0743-5. Issue: Online First, Nov. 2003. Hardcopy Vol. 36(3), pp. 455-462, 2004.

Carlson, L.E , Reitsma, R.F., Brandemuehl, M.J., Hertzberg, J.R., Sullivan, J.F. and Gabbard, S.G., (2003), Exploiting an Engineering *Building* as a Unique Distance Learning Tool, *International Journal of Engineering Education*. Vol. 19(3), pp. 379-388.

Birnbaum B, Orlando, W., Shandas R., Hertzberg J., DeGroff, C., , "Oscillatory events with steady flow boundary conditions in numerical simulations of the Fontan operation.," *Journal Of Investigative Medicine* 52, no. 1 (January 2004): S170-S170.

Hyoung-Bum Kim, Jean Hertzberg, Craig Lanning, Robin Shandas, "Non-invasive measurement of steady and pulsating velocity profiles and shear rates in arteries using echo PIV: In vitro validation studies," *Annals of Biomedical Engineering,* **32** (8): 1067-1076, August 2004.

J.R. Hertzberg and A. Sweetman, "A Course in Flow Visualization: the Art and Physics of Fluid Flow," 2004 ASEE Annual Conference Proceedings (reviewed), pp. 2449-2459. Session # 2480. "Best Paper of PIC III" $1000 award http://www.colorado.edu/MCEN/flowvis/ASEEpaper.pdf.

Mukdadi, O.M.; Hyoung-Bum Kim; Hertzberg, J.; Shandas, R., "Numerical modeling of microbubble backscatter to optimize ultrasound particle image velocimetry imaging: initial studies," *Ultrasonics*, **42** (10), pp. 1111-21, 2004.

Weinberg, C.E., Hertzberg, J.R., Ivy, D., Kirby, K. S., Chan, K.C., Valdes-Cruz, L., Shandas, R., "Extraction of Pulmonary Vascular Compliance, Pulmonary Vascular Resistance, and Right Ventricular Work From Single-Pressure and Doppler Flow Measurements in Children With Pulmonary Hypertension: a New Method for Evaluating Reactivity In Vitro and Clinical Studies," *Circulation*, **110**, pp. 2609-2617, 2004.

Poon, M., Todd, J., Neilson, R., Grace, D., Hertzberg, J., "Saffman-Taylor Instability in a Hele-Shaw Cell," *Physics of Fluids*, **16**(9), pp. S9, 2004. Gallery of Fluid Motion image. http://pof.aip.org/pof/gallery/pdf/2004/S9_1.pdf

Hertzberg, J. and Sweetman, A., "Images of Fluid Flow: Art and Physics by Students" *Journal of Visualization*, **8**(2), pp. 145-152, 2005.

DeGroff, C. Birnbaum, B.; Shandas, R.; Orlando, W.; Hertzberg, J. "Computational simulations of the total cavo-pulmonary connection: insights in optimizing numerical solutions" *Medical Engineering & Physics*, **27(**2), pp 135-46, 2005

Zheng, Hairong; Mukdadi, Osama; Kim, Hyoungbum; Hertzberg, Jean R.; Shandas, Robin "Advantages in using multifrequency excitation of contrast microbubbles for enhancing echo particle image velocimetry techniques: Initial numerical studies using rectangular and triangular waves**"** *Ultrasound in Medicine and Biology*, **31**(1), pp 99-108, 2005.

P. Miller, K. Danielson, G.Moody, A.Slifka, E.Drexler and J.Hertzberg "Matching index of refraction using a diethyl phthalate/ethanol solution for in vitro cardiovascular models. Experiments in Fluids, Online First edition, June 20, 2006, DOI: 10.1007/s00348-006-0146-5, http://dx.doi.org/10.1007/s00348-006-0146-5. Hardcopy: 41:375-381, 206.

Zheng, Hairong; Liu, Lingli; Williams, L.; Hertzberg, J.R.; Lanning, C.; Shandas, R. "Real time multicomponent echo particle image velocimetry technique for opaque flow imaging" *Applied Physics Letters*, v 88, n 26, 26 June 2006, p 261915-1-3 http://scitation.aip.org/journals/doc/APPLAB-ft/vol_88/iss_26/261915_1.html

R.Wang, K.Hunter, J.Hertzberg, F.Lacour-Gayet, R.Shandas. "A Novel Microaxial Venous Assist Device for Enhancing Pulmonary Flow and Reducing Venous Pressure within the Total Cavopulmonary Connection: Computational Fluid Dynamic Studies". *Journal of the American College of Cardiology*, V4, pp.238 (2006)

N. Ross, E. Bradley, and J. Hertzberg, "Dynamics-Informed Data Assimilation in a Qualitative Fluids Model,"20th International Workshop on Qualitative Reasoning, 2006 http://www.cs.dartmouth.edu/~qr06/papers/ross-bradley-hertzberg-qr06.pdf . Note: this is a highly reviewed and competitive conference.

R.Wang, F.Lacour-Gayet, Craig J. Lanning, B.A. Rech, P.J. Kilfoil, J.Hertzberg, R.Shandas. "Initial Experience with the Development and Numerical and In Vitro Studies of A Novel Low-Pressure Artificial Right Ventricle for Pediatric Fontan Patients". *ASAIO Journal*, v 52, n 6, November/December, 2006, p 682-692 DOI: 10.1097/01.mat.0000249038.69048.3c

Read, Timothy; Ladtkow, Tanner; Fabri, Andrea; Hertzberg, Jean "Beading Up". *Physics of Fluids*, v 19, n 9, September, 2007, p 091105. DOI: 10.1063/1.2775407. http://link.aip.org/link/?PHFLE6/19/091105/1

Fujisawa, N., Verhoeckx, M., Dabiri, D, Gharib, M. and Hertzberg, J. "Recent Progress in Flow Visualization Techniques Toward the Generation of Fluid Art," *Journal of Visualization*, v 10, n2, p 163-170, 2007. http://www.jov.jp/pdf/Vol10_No2/Regular_paper/Fujisawa.pdf

John Giardino, Jean Hertzberg, and Elizabeth Bradley, “A calibration procedure for millimeter-scale stereomicroscopic particle image velocimetry,” *Experiments in Fluids* 45 (2008): 1037-1045, doi:10.1007/s00348-008-0525-1.

L.L. Liu, O.M. Mukdadi, M.K. Tripp, C.F. Herrmann, J.R. Hertzberg, S.M. George, V.M. Bright, and R. Shandas, “Atomic layer deposition for fabricating capacitive micromachined ultrasonic transducers: initial characterization”, *Sensors and Materials*, 20, no. 1 (2008): 15-34.

L.L. Liu, H.R. Zheng, F. Zhang, L.D.A. Williams, J.R. Hertzberg and R. Shandas, "Development of a custom designed echo particle image velocimetry system for multi-component hemodynamics measurement: system characterization and initial experiments", *Physics in Medicine and Biology*, Volume: 53 Issue: 5 Pages: 1397-1412 (2008).

William Kerwin, David Owens, Jean Hertzberg, Robin Shandas, Edward Gill, “Vortex Ring Formation in Diastolic Dysfunction: Phase Contrast MRI of Left Ventricular Filling” Poster 1377, Best Poster in Flow and Motion category, Proceedings of the 16th Scientific Meeting of the International Society for Magnetic Resonance in Medicine, Toronto, Canada, 3-9 May 2008.

Natalie Ross, Jean Hertzberg, and Elizabeth Bradley, “Discretization of the vorticity field of a planar jet,” *Experiments in Fluids* (4, 2010), http://www.springerlink.com/index/10.1007/s00348-010-0862-8.

Meg VanSciver, Shelly L. Miller, and Jean R. Hertzberg, “Particle Image Velocimetry of Human Cough,” *Aerosol Science and Technology* 45, no. 3 (March 2011): 415. DOI:10.1080/02786826.2010.542785

Jean Hertzberg, Bailey Leppek, and Kara Gray, “Attitudes Towards Fluids: the Impact of Flow Visualization” 119th ASEE Annual Conference and Exposition, San Antonio, TX., June 10 - 13. Reviewed. (2012).

Fenster, Brett E., Joyce D. Schroeder, Jean R. Hertzberg, and Jonathan H. Chung. “4-Dimensional Cardiac Magnetic Resonance in a Patient With Bicuspid Pulmonic Valve: Characterization of Post-Stenotic Flow.” *J Am Coll Cardiol* 59, no. 25 (June 19, 2012): e49.

James McNeill, Jean Hertzberg , and Zhiqian (John) Zhai, “Field Measurements of Thermal Conditions During Surgical Procedures for the Development of CFD Boundary Conditions (RP-1397),” *ASHRAE Transactions* 118, no. 2 (October 2012): 596-609.

James McNeill, Jean Hertzberg, and Zhiqiang (John) Zhai. “Experimental Investigation of Operating Room Air Distribution in a Full-Scale Laboratory Chamber Using Particle Image Velocimetry and Flow Visualization.” *Journal of Flow Control, Measurement and Visualization* 1, no. 1 (April 2013): 24–32. doi:http://dx.doi.org/10.4236/2760005.

Fenster, Brett, Jamey Browning, Aurelien F. Stalder, Christopher Glielmi, Lori Silveira, J. K. Buckner, Alex Kluiber, Joyce D. Schroeder, and Jean Hertzberg. “Vorticity for the Assessment of Right Ventricular

Diastolic Dysfunction Using 4D Flow CMR." *Journal of Cardiovascular Magnetic Resonance* 15, no. Suppl 1 (January 30, 2013): P8. doi:10.1186/1532-429X-15-S1-P8.

Jean Hertzberg, Brett Fenster, Jamey Browning, and Joyce Schroeder. "Application Spotlight: PCV Applied to Cardiac Flow." In *Fluid Mechanics Fundamentals and Applications*, pg 416. 2nd ed. McGraw-Hill Science/Engineering/Math, 2013.

McQuillan B, Hertzberg J, Montoya LD, Flow Visualization Study of Synthetic Flow Control in the Indoor Environment, *Building and Environment* (2014), doi: 10.1016/

j.buildenv.2013.12.002

Yan Tan, Daren Wang, Wei Tan, Kurt Stenmark, Jean Hertzberg, and Kedall Hunter. "Artery Stiffening Induces Downstream Endothelial Inflammation via a TLR2/NF-kB Pathway." *PLoS ONE* submitted (September 18, 2013).

Written Conference Papers and Reports (Non-refereed)

M. Thornton, P. Malte, P. Kamber and J. Hertzberg, "Combustion of Wood Volatiles," Western States Section, Combustion Institute, Paper 31-81, 1981.

J. Hertzberg, L. Talbot, "Premixed Flame Stabilization on a Bluff Body," Paper 86-22, Western States Section, Combustion Institute, Fall 1986 Meeting.

J. Hertzberg, C.M. Ho, "Behavior of Confined Shear Layers in a Rectangular Sudden Expansion," paper presented at 3rd Int'l Congress on Fluid Mechanics, Cairo, Egypt, Jan. 1990.

J. Hertzberg, C.M. Ho, "Time Averaged 3d Flow in a Rectangular Sudden Expansion," Paper 91-0040 at the AIAA 29th Aerospace Sciences Meeting, Reno, Jan. 1991.

J. Hertzberg, and C.M. Ho, "Phase Locked Velocity Measurements in a Rectangular Sudden Expansion," Proceedings of the Int'l Symp. on Pulsating Combustion, Monterey, CA, August 1991, sponsored by Sandia National Labs and the Gas Research Institute.

P. Zmarzly, J.R. Hertzberg, J.W. Daily, "LDV Measurements of Silica Particles in an Electric Field Enhanced Outside Vapor Deposition Flame," Paper 93-085, Western States Section Combustion Institute Fall

Meeting, SRI International, October 1993. Also Center for Combustion Research (CCR) Report No. CCR 93-07, University of Colorado, Boulder, 1993.

R.G. McGuffin, B.P. Heiler, J. Hertzberg, J.W. Daily, J.T. McKinnon, "Combustion of High Energy Fuels," Paper WSS/CI 94-040, Western States Section/Combustion Institute Spring Meeting, University of California, Davis, March 21-22, 1994. Also CCR Report No. 94-01.

J. Hertzberg, G. Fiechtner, D. Shaefer, A. Karandyszowski, M. Foster, "A Bifurcated Diffusion Flame," Paper WSS/CI 94-048, Western States Section/Combustion Institute Spring Meeting, University of California, Davis, March 21-22, 1994. Also CCR Report No. 94-03.

T.Y. Chang, J.R. Hertzberg, K. Center, S. Mahalingam, R. Kerr "Vortex Dynamics in Compact Waste Incinerators," Work-In-Progress Poster Presentation, 25th International Symposium on Combustion, UC Irvine, July 31-August 5, 1994. Full paper, CCR Report No. 94-06.

J. Hertzberg, J.W. Daily, J.T. McKinnon, R.G. McGuffin, E.J. Poulin, A.B. Bird,

"Combustion of High Energy Fuels," Proceedings of the Seventh ONR Propulsion Meeting, pp. 145-152, SUNY Buffalo, August 1994. Also CCR Report No. 94-04.

J. Hertzberg, M. Linne, "Three-Dimensional Flow in a Microgravity Diffusion Flame," Third International Microgravity Combustion Conference, Cleveland OH, April 11-13, 1995, NASA Conference Publication 10174, pp. 363-368. Also CCR Report No. 95-01.

K. Anderson, T. Chang, K. Center, J. Hertzberg, S. Mahalingam, R. Kerr, "Vortex Dynamics in Compact Waste Incinerators," Fifteenth International Colloquium on the Dynamics of Explosions and Reactive Systems, Proceedings pp. 270-273, University of Colorado, Boulder, August 1995.

R. McGuffin, E. Poulin, A. Bird, J. Daily, J. Hertzberg, "Combustion Instability in a Dump Combustor," Fifteenth International Colloquium on the Dynamics of Explosions and Reactive Systems, Proceedings pp. 278-281, University of Colorado, Boulder, August 1995.

J. Hertzberg, J. Daily, J. T. McKinnon, R. McGuffin, E. Poulin, A. Bird, "Effect of Increased Energy Release on Combustion Characteristics and an Ab Initio Study of Dihydrobenzvalene Isomerization," Proceedings of the Eighth Annual Office of Naval Research Propulsion Meeting, pp. 242-251, University of California at San Diego, October 11-13,1995. Also CCR Report No. 95-04.

K. Anderson, K. Center, S. Mahalingam, J. Hertzberg, “Effects of Active Forcing on Non-Premixed Combustion in Coflowing Jets,” AIAA 96-0757, 34th Aerospace Sciences Meeting and Exhibit, January 15-18, 1996, Reno, NV. Also CCR Report No. 96-02.

K. Center, K. Anderson, S. Mahalingam, J. Hertzberg, “Simulation of Reacting Vortex Structures Within a Confined Domain,” AIAA 96-0709, 34th Aerospace Sciences Meeting and Exhibit, January 15-18 1996, Reno, NV. Also CCR Report No. 96-03.

R.G. McGuffin, E.J. Poulin, J.W. Daily, J.R. Hertzberg, “Effect of Energy Release on Combustion Instability,” Paper Number WSS 96S-014, Spring Meeting Western States Section / the Combustion Institute, Tempe, AZ, March, 1996. Also CCR Report No. 96-04.

J. D. Luff, A. M. Rompage, M. A. Linne, J.R. Hertzberg, “Uncertainties Associated with the Post-Processing of 2-D Particle Image Velocimetry (PIV) Velocity Data of Unsteady Flow Fields,” Paper Number WSS 96S-005, Spring Meeting Western States Section / the Combustion Institute, Tempe, AZ, March, 1996.

R.G. McGuffin, E.J. Davis, J.W. Daily, J.R. Hertzberg, “Effect of Energy Release on Combustion Instabilities,” Proceedings of the Ninth Annual Office of Naval Research Propulsion Meeting, September 9-12, 1996,Arlington VA, pp. 243-253.

K.R. Anderson, K.B. Center, J.R. Hertzberg, S. Mahalingam, “Simulation of Non-Premixed Actively Forced Vortical Structures Within a Confined Domain,” Paper 96F-107, Fall Meeting Western States Section / the Combustion Institute, October 28-29, 1996, University of Southern California, L.A., CA.

J. Carlton, J. R. Hertzberg, M. Schwieterman and M. Linne, “Splitting of an Axially Excited Jet Diffusion Flame,” Proceedings of the First International Symposium on Flow Visualization and Image Processing, Volume 2, pp. 525-530. Honolulu, Hawaii, February 23-26, 1997. Sponsored by the Pacific Center of Thermal-Fluids Engineering. Also CCR Report No. 96-08.

J. Hertzberg, J. Carlton, M. Schwieterman, E. Davis, E. Bradley, “Splitting of Forced Elliptic Jets and Flames,” Fourth International Microgravity Combustion Workshop, Cleveland, OH, May 19-21, 1997. NASA Conference Publication 10194, pp. 135-140.

T. Drouilliard, P. McCarthy, M. Linne, J. Carlton, J. Hertzberg, “PIV Measurements in an Acoustically Forced Asymmetric Jet Flame”, 37th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 11-14, 1999

J.Carlton, J. Hertzberg, K. Foerster, M.Linne, “Side Jet Formation and Split Flames,” First International Symposium on Turbulence and Shear Flow Phenomena, Santa Barbara, CA, September 12-15, 1999. Proceedings: Banerjee and Eaton, editors, Begell House Publishers, pp 207-212.

Cooke J, Hertzberg J, Lanning C, and Shandas R. “Effects of Velocity History on Vortex Characteristics in a Mitral Flow Model”, Proceedings of ICMMB-11: International Conference on Mechanics in Medicine and Biology, April 2-5, 2000, Maui, Hawaii, pp. 101-103.

R. Shandas, J. Hertzberg, J. Cooke, M. Boardman. “Left Ventricular Filling Dynamics: Particle Image Velocimetry and Ultrasound Color M-Mode Imaging” ASME Int’l ME Congress and Expo, NY, NY 11/11-11/16/2001.

R. Shandas, J. Hertzberg, "Flow Visualization of the Cobe Centrifugal Blood Pump" Research Report, September, 2001.

E. Bradley, J. Hertzberg, Y.C Lee, X.C. Cai, T. Peacock, Annual Report for NSF-ITR-0083004, "An Interactive Experimental/ Numerical Simulation System with Applications to MEMS"

E. Collier, J. Hertzberg, R. Shandas, "Regression analysis for vortex ring characteristics during left ventricular filling," Rocky Mountain Bioengineering Symposium, Copper Mtn, April 2002. *Biomedical Sciences Instrumentation,* **38**, pp 307-311.

W. Orlando, J. Hertzberg, R. Shandas and C. DeGroff, "Reverse flow in compliant vessels and its implications for the fontan procedure: numerical studies" Rocky Mountain Bioengineering Symposium, Copper Mtn, April 2001. *Biomedical Sciences Instrumentation,* **38**, pp 321-326.

H.B. Kim, J.R. Hertzberg and R. Shandas, "Development of an ECHO-PIV Technique and Validation in Pipe Flow", Paper IMECE2002-32256, BED-Vol. 53, 2002 Advances in Bioengineering ASME 2002. Session BED11A, ASME Int'l Mechanical Engineering Congress and Symposium, November 17-22, New Orleans, LA, 2002

H.-B. Kim, J.Hertzberg, and R. Shandas "*In vitro* study of wall shear stress measurement using Echo-PIV technique". 2003 ASME Summer Bioengineering Conference, June 25-29, Sonesta Beach Resort in Key Biscayne, Florida

Shandas R, Kim HB, Hertzberg JR, Mukdadi O: An ultrasound based method for measuring multiple velocity components in opaque macro and micro flows, TRANSDUCERS '03. 12th International Conference on Solid-State Sensors, Actuators and Microsystems. Digest of Technical Papers (Cat. No.03TH8664), 2003, pt. 1, p 919-22 vol.1

Shandas R, Kim HB, Hertzberg JR, DeGroff CG, Monet E, Valdes-Cruz LM: In Vivo Validation of the Echo-PIV Technique: Animal and Clinical Studies, Proceedings of the ASME Summer Bioengineering Conference, 2003.

Mukdadi O, Kim HB, Hertzberg JR, Shandas R: On the Enhancement of Ultrasound Backscatter from Microbubbles for Optimal Particle Image Velocimetry, Proceedings of the ASME Summer Bioengineering Conference, 2003.

Weinberg CE, Hertzberg JR, Chan KC, Kirby KS, Valdes-Cruz LM, Shandas R: Evaluation of Pediatric Pulmonary Artery Input Impedance using Windkessel Models and Doppler Ultrasound: In Vitro and Clinical Studies, Proceedings of the ASME Summer Bioengineering Conference, 2003.

H-B Kim, J.R. Hertzberg, R. Shandas, "Echo PIV for flow field measurements in vivo," Rocky Mountain Bioengineering Symposium, Fort Collins CO, April 2004 *Biomedical Sciences Instrumentation*, v 40, 2004, p 357-363.

Timothy Drost, Tiffany Zimmer, Hyoung-Bum Kim, Robin Shandas, Jean Hertzberg, "Study of In Vitro Mitral Valve Filling Flow," Rocky Mountain Bioengineering Symposium, Fort Collins CO, April 2004 *Biomedical Sciences Instrumentation*, v 40, 2004, p 350-356.

Zheng, Hairong, Mukdadi, Osama; Hertzberg, Jean; Shandas, Robin "Advantages in using multi-frequency driving ultrasound for optimizing echo particle image velocimetry techniques" Rocky Mountain Bioengineering Symposium, Fort Collins CO, April 2004 *Biomedical Sciences Instrumentation*, v 40, 2004, p 371-376

Liu, L.L., Mukdadi, O.M.; Hertzberg, J.R.; Shandas, R. A model study of capacitive micromachined ultrasonic transducers fabricated using atomic layer deposition process Rocky Mountain Bioengineering Symposium, Fort Collins CO, April 2004 *Biomedical Sciences Instrumentation*, v 40, 2004, p 142-148.

Hertzberg, J.R. and Sweetman, A., "Art And Physics: A Flow Visualization Course And Outreach Experience," 11th International Symposium On Flow Visualization

August 9-12, 2004, University of Notre Dame, Notre Dame, Indiana, USA

CD ROM, paper 251.

John P Giardino, Jean R Hertzberg, Elizabeth Bradley “Stereomicroscopic particle image velocimetry” 11th International Symposium On Flow Visualization

August 9-12, 2004, University of Notre Dame, Notre Dame, Indiana, USA

CD ROM, paper 247.

William S. Kerwin, Edward Gill, Jason Cooke, Jean Hertzberg, Heather Chluda, Robin Shandas “Vorticity Imaging of Diastolic Cardiac Inflow by Phase-Contrast MRI,” Proceedings of the 2004 IEEE International Symposium on Biomedical Imaging: From Nano to Macro, Arlington, VA, USA, 15-18 April 2004. pp.300-303.

Hairong Zheng, Osama Mukdadi, Hyoung Bum Kim, Jean R. Hertzberg, Robin Shandas, “Advantages in Using Multi-Frequency Driving to Enhance Ultrasound Contrast Microbubble Non-Linearities for Optimizing Echo Particle Image Velocimetry Techniques,” Proceedings of the 2004 IEEE International Symposium on Biomedical Imaging: From Nano to Macro, Arlington, VA, USA, 15-18 April 2004 pp. 500-503.

Osama Mukdadi, Hyoung Bum Kim, Jean R. Hertzberg, Robin Shandas, “Numerical Modeling of Ultrasound Imaging Using Contrast Agents for Particle Image Velocimetry In Vivo,” Proceedings of the 2004 IEEE International Symposium on Biomedical Imaging: From Nano to Macro, Arlington, VA, USA, 15-18 April 2004. pp.504-507.

Lingli Liu, Osama Mukdadi, Hyoung Bum Kim, Jean R. Hertzberg, Robin Shandas, Victor Bright, “Atomic Layer Deposition for Fabricating Capacitive Micromachined Ultrasonic Transducers: Initial Characterization,” Proceedings of the 2004 IEEE International Symposium on Biomedical Imaging: From Nano to Macro, Arlington, VA, USA, 15-18 April 2004. pp. 512-515.

L.L. Liu, O.M. Mukdadi, C.F. Herrmann, R.A. Saravanan, J.R. Hertzberg, S. M. George, V.M. Bright, and R. Shandas, “A Novel Method for Fabricating Capacitive Micromachined Ultrasonic Transducers with Ultra-Thin Membranes”, IEEE Ultrasonics and Ferrofrequency Control Conference, Montreal, Canada, pp.487-500, 8/2004

Jean Hertzberg, Alex Sweetman, “Art And Physics: A Flow Visualization Course”

Art+Math=X International Conference Proceedings, pg 104-108. Boulder, CO, June 2-5, 2005.

Jean Hertzberg, Alex Sweetman, “Imaging for the Love of Fluid Flow,” Scart4: Science and Art International Symposium (4th) New Brunswick, NJ, June 10-12, 2005

Paul Miller, Kurt Danielson, Jean Hertzberg, Andy Slifka, Elizabeth Drexler, Galan Moody,“ Using Diethyl Phthalate/ Ethanol Solution for In Vitro Cardiovascular Models” Poster I-88, Finalist for Best Undergraduate Paper. ASME 2005 Summer Bioengineering Conference. June 22-26, Vail, CO.

Rui Wang, Jean Hertzberg, Robin Shandas, “A Numerical Study Of Vortex Flow During Ventricular Filling” ASME 2005 Summer Bioengineering Conference. June 22-26, Vail, CO.

James Nabity, Sean Rooney, John Daily, Eric Johnson and Jean Hertzberg “An Electrostatically Actuated MEMS Fuel Injector to Enhance Low-Pressure Atomization,” *Collection of Technical Papers - 44th AIAA Aerospace Sciences Meeting*, v 13, 2006, p 9678-9683.

R.Wang, R.Shandas, K.Hunter, C.Lanning, J.Hertzberg, F.Lacour-Gayet. “Design and computational studies of A Novel Miniature Venous Assist Device for the Fontan circulation”, ASME Summer Bioengineering Conference, Florida (2006).

Lingli Liu, Hairong Zheng, Jean Hertzberg, Robin Shandas "Real Time Blood Velocity And Vorticity Measurements Using A Custom-Designed Non-Invasive Echo

Particle Image Velocimetry System: Initial In Vitro Experiments" ASME Summer Bioengineering Conference, Florida (2006).

J. Hertzberg and A. Sweetman "Beautiful Physics from Ordinary Fluids" Paper 213, 12th International Symposium on Flow Visualization, Gottingen, Germany, Sept. 10-14, 2006

Hyoung-Bum Kim, Chung-Hwan Ryu, Sang-Hyuk Lee and J. Hertzberg, "Development of an In-Plane Scanning PIV Method" Paper 121, 12th International Symposium on Flow Visualization, Gottingen, Germany, Sept. 10-14, 2006

Lingli Liu, Hairong Zheng, Logan Williams, Jean Hertzberg, Craig Lanning and Robin Shandas, "A Custom-Designed Ultrasound Echo Particle Image Velocimetry System: Initial Experiments" Paper 209.

Proceedings of the Fifth International Symposium on Ultrasonic Doppler Methods for Fluid Mechanics and Fluid Engineering, pp 27-30,

Swiss Federal Institute of Technology (ETHZ), Zürich, Switzerland

12 - 14 September 2006

Vargas, Yury Loayza; Finley, Tiffany J.; Mohseni, Kamran; Hertzberg, Jean "Flow characterization of a synthetic jet".

Collection of Technical Papers - 44th AIAA Aerospace Sciences Meeting, v 22, 2006, p 17115-17126.

Hertzberg, J., Gray, K., Sweetman, A.. "Impact and Outcomes of a Flow Visualization Course" ISFV13 - 13th International Symposium on Flow Visualization . Paper 186
July 1-4, 2008, Nice, France

Hertzberg, J., Sweetman, A.. "Impact and Outcomes of a Flow Visualization Course" Proceedings of FEDSM2009, ASME 2009 Fluids Engineering Division Summer Meeting, August 2-6, 2009, Vail, Colorado Paper no. FEDSM2009-78480," in *ASME Conference Proceedings*, vol. 2, pp 269-275, doi:10.1115/FEDSM2009-78480.

John Zhai, Jean Hertzberg, Wade Smith, Greg Quinn, and James McNeill. Experimental Investigation of Hospital Operating Room (OR) Air Distribution. Final Report TRP-1397. ASHRAE, September 30, 2013. http://bechtel.colorado.edu/~zhiqiang/ASHRAE_1397RP_FinalReport_v8.pdf.

Conference Presentations, Posters and Abstracts

J. Hertzberg, M. Namazian, L. Talbot, "The Structure of a Rod-Stabilized Premixed, Turbulent Flame," Work-In-Progress Poster PS-13, Twentieth Symposium (International) on Combustion, Book of Abstracts, pg. 119, 1984.

J. Hertzberg, L. Talbot, "Premixed Flame Stabilization on a Bluff Body," Work-In-Progress Poster PS-123, Twenty-first Symposium (International) on Combustion, Book of Abstracts, pg. 209, 1986.

J. Hertzberg, L. Talbot, “Vortex Shedding and the Stabilization of V-Shaped Flames,” Work-In-Progress Poster PS-69, Twenty-Second Symposium (International) on Combustion, Book of Abstracts, pg. 164, 1988.

J. Hertzberg, C.M. Ho, “Vortex Dynamics in an Isothermal Rectangular Dump Combustor,” Work-In-Progress Poster PS-70, Twenty-Second Symposium (International) on Combustion, Book of Abstracts, pg. 165, 1988.

J. Hertzberg, C.M. Ho, “Vortex Dynamics in a Rectangular Sudden Expansion,” presentation at 41st Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract published in *Bull. A.P.S*. Vol. 33, no. 10, pg. 2233, Nov. 1988.

J. Hertzberg, C.M. Ho, “Flow in a Rectangular Sudden Expansion,” presentation at 42nd Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract published in *Bull. A.P.S*. Vol. 34, no. 10, pg. 2341, Nov. 1989.

T. Austin, J. Hertzberg, C.M. Ho, “Entrainment of Three-Dimensional Shear Flows,” presentation at 4th Asian Congress on Fluid Mechanics, Hong Kong, Dec. 1989.

J. Hertzberg, C.M. Ho, “Phase Locked 3d Velocity Field of a Rectangular Sudden Expansion,” presentation at 43rd Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract published in *Bull. A.P.S.* Vol. 35, no. 10, pg. 2257, Nov. 1990.

J.R. Hertzberg and C.M. Ho, “Three-Dimensional Flow in a Rectangular Sudden Expansion,” Work-In-Progress Poster P257, Twenty-Fourth Symposium (International) on Combustion, Book of Abstracts, pg. 380, 1992.

T. Chang and J. Hertzberg, “Study of Asymmetric Vortex Ring Near Walls,” presentation at the 45th Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract published in *Bull. A.P.S*. Vol. 37, no. 8, pg. 1780, Nov. 1992.

T.Y. Chang, J.R. Hertzberg, R. Kerr, “Interaction of an Elliptic Vortex Ring and a Wall,” presentation DD8 at the 46th Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract in *Bull. A.P.S.* **38** (12):2230, Nov. 1993.

R.G. McGuffin, E.J. Poulin, A.B. Bird, J. Hertzberg, J.W. Daily, J.T. McKinnon, “Combustion of High Energy Fuels,” Work-In-Progress Poster 5-44, 25th International Symposium on Combustion, University of California, Irvine, July 31-August 5, 1994. Abstract published in W-I-P Abstracts Book, pg. 430.

T.Y. Chang, J.R. Hertzberg, K. Center, S. Mahalingam, R. Kerr, “Vortex Dynamics in Compact Waste Incinerators,” Work-In-Progress Poster 5-57, 25th International Symposium on Combustion, University of California, Irvine, July 31-August 5, 1994. Abstract published in W-I-P Abstracts Book, pg. 443.

B. Asgarian, E. Papadopolo, E. Schrader, D. Schaefer, A. Karandyszowski, M. Foster, J. Hertzberg, “A Bifurcated Diffusion Flame,” Work-In-Progress Poster 2-63, 25th International Symposium on Combustion, University of California, Irvine, July 31-August 5, 1994. Abstract published in W-I-P Abstracts Book, pg. 155.

J.R. Hertzberg, John D. Carlton, M. Linne, E. Bradley, “A split, bifurcated diffusion flame,” Forty-Eighth Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract in *Bull. of the A.P.S.* **40** (12), pp. 2015. 1995

K. Anderson, K. Center, S. Mahalingam, J. Hertzberg, “Direct numerical simulation of coflowing asymmetric reacting jets,” Forty-Eighth Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract in *Bull. of the A.P.S.*, **40** (12) pp. 1991-2, 1995.

J.D. Luff, A.M. Rompage, M.A. Linne and J.R. Hertzberg, “Uncertainties Associated with Post-Processing of PIV Data,” Work in Progress Poster 5-017 , 26th Symposium on Combustion, Naples, Italy, July 29-August 2, 1996. Abstract published in W-I-P Abstracts Book, pg. 371.

K.R. Anderson, K.B. Center, J.R. Hertzberg, S. Mahalingam, “Simulation of Non-Premixed Coflowing Jets Within a Confined Domain,” Work in Progress Poster 2-110 , 26th Symposium on Combustion, Naples, Italy, July 29- August 2, 1996. Abstract published in W-I-P Abstracts Book, pg. 233.

J. Hertzberg, J. Carlton, M. Schwieterman, E. Bradley, M. Linne, T. Settersten, “Splitting of an Axially Excited Jet Diffusion Flame,” Work in Progress Poster 2-017 , 26th Symposium on Combustion, Naples, Italy, July 29- August 2, 1996. Abstract published in W-I-P Abstracts Book, pg. 140.

R.G. McGuffin, J.R. Hertzberg, J.W. Daily, “Effect of Energy Release on Combustion Instability,” Work in Progress Poster 5-045 , 26th Symposium on Combustion, Naples, Italy, July 29- August 2, 1996. Abstract published in W-I-P Abstracts Book, pg. 399.

J.R. Hertzberg, John D. Carlton, M. Linne, E. Bradley, M. Schwieterman “Splitting of an Axially Excited Jet Diffusion Flame,” 1996 International Mechanical Engineering Conference and Exposition, Atlanta, GA, American Society of Mechanical Engineers, November 17-22, 1996.

K. Anderson, K. Center, S. Mahalingam, J. Hertzberg “Direct numerical simulation of coflowing reacting jets” Forty-Ninth Annual Meeting of the Division of Fluid Dynamics of the American Physical Society, abstract in *Bull. of the A.P.S.*, **41** (12), 1996.

J. Luff, T. Drouillard, A. Rompage, J. Hertzberg and M. Linne, “Experimental Uncertanties Associated with Particle Image Velocimetry (PIV) Based Vorticity Algorithms,” Gordon Conference on the Physics and Chemistry of Laser Diagnostics in Combustion, Plymouth NH, poster, July 1997.

J. Carlton, J. Hertzberg, and M. Linne, “Side Jet Formation and Split Flames,” Work in Progress Poster W2D05 , 28th Symposium on Combustion, Boulder, CO, August 2-7, 1998. Abstract published in W-I-P Abstracts Book, pg. 196.

R. Shandas, E. Gill, J. Hertzberg, C. DeGroff, L.M. Valdes-Cruz, “Quantitation and visualization of ventricular filling vortices using high frame rate echocardiography: In vitro and clinical studies (abstract)”, 72nd Scientific Sessions, American Heart Association, Atlanta, GA, November 7-10, 1999. Abstract published in *Circulation* (Suppl-I) 1999;100(18):I-364

R. Shandas, E. Nicol, C. Weinberg, C. DeGroff, J. Hertzberg, D. Ivy, L. Valdes-Cruz, "Development Of A Non-Invasive Ultrasound Color M-Mode Means Of Estimating Pulmonary Vascular Resistance In Pediatric Pulmonary Hypertension". American College of Cardiology 49th Annual Scientific Sessions, March 12-15, 2000. Abstract: *J Am. Coll. Cardiol.*, 2000;35:506A

C. Weinberg, E. Nicol, J. Hertzberg, C. DeGroff, R. Shandas, “Development of a Non-Invasive Method for Estimating Pulmonary Vascular Resistance in Pediatric Pulmonary Hypertension,” T6.151, presented at the Annual Fall Meeting of the Biomedical Engineering Society, Oct. 12-14, 2000, Seattle, WA. Abstract published in *Annals of Biomedical Engineering*, 28 Sup. 1, pp. S-77.

J. Cooke, J. Hertzberg, R. Shandas, C. Lanning, R. Knobel, M. Boardman, "Characterizing the Fluid Dynamics of Mitral Inflow: *In Vitro* Studies," T6.40, presented at the Annual Fall Meeting of the Biomedical Engineering Society, Oct. 12-14, 2000, Seattle, WA. Abstract published in *Annals of Biomedical Engineering*, 28 Sup. 1, pp. S-59.

R. Shandas, C. Weinberg, D. Ivy, S. Ge, J. Hertzberg, C. DeGroff, L. Valdes-Cruz, "Use of Doppler and color M-mode flow propagation to predict local compliance and pulmonary vascular resistance for pediatric pulmonary hypertension: *In vitro* and clinical studies," presented at the Scientific Sessions of the American Heart Association, Nov. 12-15, 2000. Abstract: *Circulation* 2000;102:II-772.

T. Peacock, V. Bright, Y-C. Lee, J. Hertzberg, and E. Bradley, "Micro-Active Control of a Planar Jet," Technical Report CU-CS (Department of Computer Science) 912-00.

J.R. Hertzberg, J.E. Cooke, M. Boardman, R. Shandas, "Diastolic Flow Forcing," ASME Summer Bioengineering Conference, Snowbird, Utah, June 2001.

J.E. Cooke, J.R. Hertzberg, M.O. Boardman, C. Lanning, R. Shandas, "Characterizing the Relationship Between Left Ventricular Inflow Dynamics and Ultrasound Color M-Mode Imaging: An *In Vitro* Study," ASME Summer Bioengineering Conference, Snowbird, Utah, June 2001.

R. Shandas, J. Cooke, J. Hertzberg, M. Boardman, C. DeGroff, L. Valdez-Cruz, "Error of the Color M Mode Technique in Quantifying Diastolic Flow Propagation," 12th Annual Scientific Sessions Of The American Society of Echocardiography, Seattle, WA, June 2001.

R. Shandas, J. Hertzberg, J. Cooke, M. Boardman, "Left Ventricular Filling Dynamics: Particle Image Velocimetry and Ultrasound Color-M Mode Imaging," International Mechanical Engineering Congress & Exposition, The Winter Annual Meeting of ASME (WAM), New York, NY November, 2001.

T. Peacock, J. Hertzberg, Y.C. Lee, E. Bradley, V. Bright "Control of a 2D Jet Using Mems" SIAM Conference on the Applications of Dynamical Systems, May 20 - 24, Snowbird, Utah, 2001.

J.R. Hertzberg, J.E. Cooke, M. Boardman, R. Shandas, "Diastolic Flow Forcing," Poster 531, ASME Summer Bioengineering Conference, Snowbird, Utah, June 2001.

J.E. Cooke, J.R. Hertzberg, M.O. Boardman, C. Lanning, R. Shandas, "Characterizing the Relationship Between Left Ventricular Inflow Dynamics and Ultrasound Color M-Mode Imaging: An *In Vitro* Study," Poster 467, ASME Summer Bioengineering Conference, Snowbird, Utah, June 2001.

R. Shandas, J. Cooke, J. Hertzberg, M. Boardman, C. DeGroff, L. Valdez-Cruz, "Error of the Color M Mode Technique in Quantifying Diastolic Flow Propagation," 12th Annual Scientific Sessions Of The American Society of Echocardiography, Seattle, WA, June 2001.

T. Peacock, E. Bradley, J. Hertzberg, Keith Julien, "Microactive control of a jet flow" Paper QJ 009, 2001 Meeting of the Division of Fluid Dynamics, American Physical Society. November 18-20, San Diego, CA.

C.G. DeGroff, S. Bhatikar, J. Hertzberg, R. Shandas, L. Valdes-Cruz, R. Mahajan. "Training an Artificial Neural Network to Distinguish Between Innocent and Pathologic Heart Murmurs". Poster 009, Colorado Alliance for Bioengineering Expo 2001. Aurora, CO, December 2001.

C.G. DeGroff, W. Orlando, J. Hertzberg, R. Shandas, L. Valdes-Cruz. "Effect of Reverse Flow on the Fluid Dynamics of the Total Cavo-Pulmonary Connection: A Potential Cause of Progressive Heart Failure". American College of Cardiology 50th Annual Scientific Sessions. Abstract in *J Am Coll Cardiol*, **39**, pg 407A

H.-B. Kim, J.Hertzberg, and R. Shandas "Echo-piv®: a novel method for the non-invasive measurement of velocity vectors using ultrasound imaging" Fourth World Congress on Biomechanics, August 4-9, 2002, Calgary, Canada. Journal article submitted to Experiments in Fluids, Dec. 2002.

H. –B. Kim, J. Hertzberg, and R. Shandas "Echo-PIV: Particle Image Velocimetry from Ultrasound Images" KC 007, 56th Annual Division of Fluid Dynamics, APS Meeting, East Rutherford, NJ 11/23-25/2003. Abstract published in *Bulletin of the American Physical Society,* **48**(10) 188-189.

J. Hertzberg, A. Sweetman "A Course in Flow Visualization: The Art and Physics of Fluid Flow" KC 005, 56th Annual Division of Fluid Dynamics, APS Meeting, East Rutherford, NJ 11/23-25/2003. Abstract published in *Bulletin of the American Physical Society,* **48**(10) 188.

Jean Hertzberg, John Giardino, Elizabeth Bradley. "A Stereo-Microscopic Particle Image Velocimetry System" Paper NC-001. American Physical Society 57th Annual Meeting of the Division of Fluid Dynamics November 21-23, 2004 Seattle, Washington. Abstract published in Bulletin APS Vol 49 (9), pp 214, Nov. 2004

Andrew Shugard, Jean Hertzberg. “Carbon Monoxide Emissions from an Axially Forced Methane Jet Flame” Paper NK008 American Physical Society 57th Annual Meeting of the Division of Fluid Dynamics November 21-23, 2004 Seattle, Washington. Abstract published in Bulletin APS, Vol 49 (9), pp 228-9, Nov. 2004.

J. Hertzberg and A. Sweetman, “Art and Physics: A Flow Visualization Course and Outreach Experience”. Invited paper, DH02, 2005 Winter Meeting of the American Association of Physics Teachers. Albuquerque, NM, January 8-12, 2005. Abstract published in *The Announcer*, Vol 34, pg 106.

Colleen Stroud, Jean Hertzberg, Melvyn Branch, "Flame Impinging on a Roller" Image and text submitted to the NSF/Science Visualization Challenge, 5/31/05.

Curated a show of Flow Visualization images at Core New Art Space, 6/1/05-6/18/05, Denver, CO as part of Art+Math=X International Conference .

Jean Hertzberg, Images presented at the Dance Finale of the Boulder Fringe Festival, Boulder, CO, Aug 27, 2005

Jean Hertzberg, Julie Meg VanSciver, Shelly Miller “Flowfield of a Human Cough” Paper HA00001, 58th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Nov 20-22 2005, Chicago, Il. Abstract published in Bulletin APS, Vol 50, no. 9, pg 181.

Paul Miller, Kurt Danielson, Galan Moody, Andy Slifka, Elizabeth Drexler, Jean Hertzberg “Refractive index matching using a diethyl phthalate/ ethanol solution”, Paper GH 00005, 58th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Nov 20-22 2005, Chicago, Il. Abstract published in Bulletin APS, Vol Vol 50, no. 9, pg 167.

Natalie Ross, Elizabeth Bradley, Jean Hertzberg “Data Assimilation for Improved Point-Vortex Models” Paper NG 00009, 58th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Nov 20-22 2005, Chicago, Il. Abstract published in *Bulletin APS*, Vol 50, no. 9, pg 284.

Joshua Grages, Jean Hertzberg, “Turbulent spray combustion of Wd-40” Poster submitted to the Combustion Art Competition, Central States Section, Combustion Institute, Cleveland, May 21-23, 2006.

Colleen Stroud, Melvyn Branch, Jean Hertzberg, “Impinging Turbulent Flames” Poster submitted to the Combustion Art Competition, Central States Section, Combustion Institute, Cleveland, May 21-23, 2006. 2nd place winner, with $200 prize.

Jean Hertzberg “Flow Visualization for K-12 Outreach” Paper FH 00001, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Nov 19-21 2006, Tampa Bay, FL. Abstract published in *Bulletin APS*, Vol 51, no. 9, pg 117.

Chris Ostoich, Jean Hertzberg “Cream in Tea” Gallery of Fluid Motion Poster 56, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Tampa Bay, FL Nov 19-21 2006.

Chris Bonilha, Jean Hertzberg “Smoke Plume” Gallery of Fluid Motion Poster 52, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Tampa Bay, FL Nov 19-21 2006.

Geneva Wilkesanders, Jean Hertzberg “Flames From Below” Gallery of Fluid Motion Poster 55, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Tampa Bay, FL Nov 19-21 2006.

Timothy Read, Tanner Ladtkow, Andrea Fabri, Jean Hertzberg “Beading Up” Gallery of Fluid Motion Poster 54, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Tampa Bay, FL Nov 19-21 2006. Winning image.

Tanner Ladtkow, Geneva Wilkesanders, Tim Read, Andrea Fabri, Jean Hertzberg “Roll Up” Gallery of Fluid Motion Poster 54, 59th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Tampa Bay, FL Nov 19-21 2006.

Hertzberg, Jean. “From Art to Physics: A Course on Flow Visualization.” 60th Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Salt Lake City, UT, Nov 20-22, 2007. Abstract published in *Bulletin APS*, Vol 52, no. 17, pg 181.

Natalie Ross, Elizabeth Bradley, and Jean Hertzberg “Discretization of the Vorticity Field of a Planar Jet,” 61st Annual Meeting of the Division of Fluid Dynamics, San Antonio, Texas, 2008. Abstract published in *Bulletin of the American Physical Society*, vol. 53, 287-288, 2008.

John Zhai, James McNeill, Jean Hertzberg, Wade Smith, and Greg Quinn. Semi-annual Progress Report #1 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP. 2009 ASHRAE Winter Meeting, 1/24/2009, Chicago, IL.

John Zhai, James McNeill, Jean Hertzberg, Wade Smith, and Greg Quinn. Semi-annual Progress Report #2 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP. 2009 ASHRAE Meeting, 6/21/2009, Louisville KY.

Luis Loma, Paul Miller, and Jean Hertzberg, "Flow in an Aortic Coarctation," 62nd Annual Meeting of the Division of Fluid Dynamics, Minneapolis, MN, November 22-24, 2009. Abstract published in *Bulletin of the American Physical Society*, vol. 54, 187, 2009.

James McNeill, Jean Hertzberg, Zhi-Qiang Zhai "Flow Visualization of Sterile Air Flows in Surgical Environments," 62nd Annual Meeting of the Division of Fluid Dynamics, Minneapolis, MN, November 22-24, 2009. Abstract published in *Bulletin of the American Physical Society*, vol. 54, 308, 2009.

John Zhai, James McNeill, Jean Hertzberg, Wade Smith, and Greg Quinn. Semi-annual Progress Report #3 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP. 2010 ASHRAE Winter Meeting, 1/23-27/2010, Orlando FL.

John Zhai, James McNeill, Jean Hertzberg, Wade Smith, and Greg Quinn. Semi-annual Progress Report #4 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP. 2010 ASHRAE Meeting, 6/26-30/2010, Albuquerque, NM.

Jean Hertzberg "Impact of Visual Perception" Poster presentation at the NSF "Exploring How People Learn Engineering Workshop" Golden, CO. August 1-4, 2010.

James McNeill, Jean Hertzberg, and Zhiqiang Zhai, "Combined experimental and computational investigation of sterile air flows in surgical environments. QE.00006.," in *Bulletin of the American Physical Society*, vol. 55 (presented at the 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach, CA., 2010), 358, http://meetings.aps.org/Meeting/DFD10/Event/134057.

Jean Hertzberg, "Seeing Fluid Physics: Outcomes From a Course on Flow Visualization. QE.00003," Abstract in *Bulletin of the American Physical Society*, vol. 55 (presented at the 63rd Annual Meeting of the Division of Fluid Dynamics, Long Beach, CA., 2010), 358. http://meetings.aps.org/Meeting/DFD10/Event/134054.

Joseph VanAmberg, Matthew Blessinger, Dung Dinh Luu, Kevin McCoy, Jean Hertzberg, "A Turbulent Particle Laden Gas Jet in Water." Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Melissa Lucht, Jean Hertzberg, "A Biologically Imperative Jet." Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Ilya Lisenker, Jean Hertzberg, “Spinning on a Skillet.” Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Jonathan Varkovitzky, Chris Svedman, Peter Mitrano and Jean Hertzberg, “Down the Drain.” Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Corey Davis and Jean Hertzberg, “Reflection, Refraction, Diffraction and Dispersion.” Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Patrick Wessels and Jean Hertzberg, “The Sandwich, Deconstructed.” Gallery of Fluid Motion Poster, 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach CA, 2010.

Ilya Lisenker, Jean Hertzberg, “Spinning on a Skillet.” Entry in the NSF/ Science Magazine 'International Science and Engineering Visualization Challenge'. Selected as a Finalist. 2010.

John Zhai, James McNeill, Jean Hertzberg, Wade Smith, and Greg Quinn. Semi-annual Progress Report #5 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP. 2011 ASHRAE Winter Meeting, 1/29-2/2/2011, Las Vegas NV.

John Zhai, James McNeill, and Jean Hertzberg, “Semi-annual Progress Report #6 to TC 9.6 - Healthcare Facilities: Experimental Investigation of Operating Room Air Distribution ASHRAE 1397-RP” (presented at the 2011 ASHRAE Annual Meeting, Montreal, Que., Canada, 25-29 2011).

Jean Hertzberg, Bailey Leppek, Tiffany Ito, and Tim Curran., “Impact and Outcomes of a Flow Visualization Course. IMECE2011-64749” (Technical presentation only presented at the ASME 2011 International Mechanical Engineering Congress & Exposition - Congress2011, Denver, Colorado, November 11, 2011), http://www.asmeconferences.org/Congress2011/Author/ConfirmAbstract.cfm.

James McNeill, Jean Hertzberg, and John Zhai, “Buoyancy driven acceleration in a hospital operating room indoor environment. H24.00001,” in *Bulletin of the American Physical Society*, vol. 56 (presented at the 63rd Annual Meeting of the APS Division of Fluid Dynamics, Long Beach, CA., 2011), http://meetings.aps.org/link/BAPS.2011.DFD.H24.1.

Jean Hertzberg and Bailey Leppek, “Attitudes Towards Fluids: the Impact of Flow Visualization. L10.00009,” in *Bulletin of the American Physical Society*, vol. 56 (presented at the 64th Annual Meeting of the Division of Fluid Dynamics, Baltimore, MD, 2011), http://meetings.aps.org/link/BAPS.2011.DFD.L10.9.

Brett E. Fenster, A.M. Freeman, J.K. Buckner, J. Browning, J.R. Hertzberg, and J.D. Schroeder. “Pulmonary artery vortex parameters for the prediction of pulmonary vascular hemodynamics.” 55th Annual Thomas L. Petty Aspen Lung Conference. Aspen, Colorado, June 6-9, 2012. http://www.ucdenver.edu/academics/colleges/medicalschool/departments/medicine/Pulmonary/Conferences/ASPEN/Pages/2013%20Conference.aspx.

Jean Hertzberg, Bailey Leppek, and Kara Gray, “Art for the Sake of Improving Attitudes towards Engineering,” presented at the 4th Annual Symposium on STEM Education, CU Boulder, October 1 2012.

Brett Fenster, Joyce Schroeder, Luis Lasalvia, Sven Zuehlsdorff, Brad Bolster, Jean Hertzberg, and Jamey Browning, “Integrated Diagnostics Characterization of Right Ventricular Diastolic Flow Dynamics Using Four Dimensional MRI and Biomarkers,” Year End NJMRC-2010-MR-02-CMT-FENSTER, Nov. 2012.

Fenster,B, Freeman,A, Hertzberg,J, Browning,J, Buckner,J, Schroeder,J “4D CMR-Derived Pulmonary Artery Vortex Properties for the Prediction of Pulmonary Vascular Hemodynamics” Radiological Society of North America 2012 Scientific Assembly and Annual Meeting; November 25-30, 2012 Chicago IL. rsna2012.rsna.org/search/event_display.cfm?em_id=12024886

James Browning, Brett Fenster, Jean Hertzberg, and Joyce Schroeder. “Right Ventricular Hemodynamics in Patients with Pulmonary Hypertension.” Presentation; abstract in *Bulletin of the American Physical Society*, 57: no 17:272. San Diego, California USA: APS, 2012. http://meeting.aps.org/Meeting/DFD12/Event/178246.

Jean Hertzberg, “Teaching CFD as a Black Box: A Validation and Verification Approach. L30.00010,” in Presentation; abstract in *Bulletin of the American Physical Society*, San Diego, California USA, 2012, vol. 57, no 17, p. 272. http://meeting.aps.org/Meeting/DFD12/Event/178724

Jean Hertzberg. “First Day Framing Activities for SEI,” January 14, 2013. http://www.colorado.edu/sei/fac-resources/framing.html.

Jean Hertzberg, Dewey Dykstra, Noah Finkelstein, Kathleen Hinko, Mel Sabilla, Ben Van Dusen, and Stamatis Vokos. “That Is Cool: The Nature Of Aesthetics in Physics - PERC 2013 Abstract Submission Detail Page.” Round Table presented at the Physics Education Research Conference 2013, Portland, OR, July 17, 2013. http://www.compadre.org/per/perc/2013/detail.cfm?ID=5210.

Jean Hertzberg. “Aesthetics of Flow Visualization.” Poster presented at the Physics Education Research Conference 2013, Portland, OR, July 17, 2013. http://www.compadre.org/per/perc/2013/detail.cfm?ID=5211.

Brett McQuillan, Jean Hertzberg, and LUPITA MONTOYA. “On the Development of Indoor Air Quality Control Using Synthetic Jets. Paper (Poster) Number: 2CH.6.” Portland, OR, Sept. 30 - October 4, 2013. http://2013.aaar.org/.

Jean Hertzberg. “That Is Cool: The Nature Of Aesthetics in Fluid Physics.” In *Bulletin of the American Physical Society*, 58:, Number 18:164–165. Pittsburgh, PA, November 24 - 26, 2013. http://meetings.aps.org/Meeting/DFD13/Event/202604.

Jean Hertzberg. “Educational Resources Including LearnChemE.com.” Presentation at APS DFD Fluids Education Lunch Workshop presented at the American Physical Society Division of Fluid Dynamics 66th Annual Meeting, Pittsburgh, PA, November 25, 2013. https://berkeley.app.box.com/DFD-edu/1/1333134528/11931402914/1.

Jean Hertzberg. *The Power of Aesthetics*. Annual Progress Report, Standard Grant. National Science Foundation, December 8, 2013.

Invited Seminars and Papers

“Fluid Mechanics of Flame Stabilization,” Brown University, Providence R.I., October 1986.

“Flame Anchoring in Premixed Flames” University of Washington, Seattle, WA, October 1986.

“Vortex Shedding in Rod Stabilized Flames” University of Southern California, L.A. CA, October 1986.

“Vortex Shedding in Rod Stabilized Flames” California Institute of Technology, Pasadena, CA, January 1987.

“Vortex Dynamics in an Asymmetric Sudden Expansion” California Polytechnic State University, San Luis Obispo, CA, May1990.

“Vortex Dynamics in an Asymmetric Sudden Expansion” University of Colorado, Boulder, CO, May 1990.

“Behavior of Confined Shear Layers in a Rectangular Sudden Expansion” Cornell University, Ithaca, NY, August 1990.

“Behavior of Confined Shear Layers in a Rectangular Sudden Expansion” Arizona State University, Tempe, AZ, September 1990.

“Phase-Locked Three-Dimensional Flow in a Rectangular Sudden Expansion,” Colorado School of Mines, Golden, CO, April 1993.

“Combustion Fluid Mechanics” Talk for ASME CU Boulder student chapter. February 1997.

“Split Jets and Flames in Microgravity,” NASA Lewis, Cleveland OH, October 1997.

“Cardiac Fluid Dynamics,” CU Boulder student chapter of the Biomedical Engineering Society, April 2001.

“Modeling Mitral Flow Data,” Applied Mathematics Colloquium, Tuesday February 4, 2003, CU Boulder.

“Flow Visualization” with Alex Sweetman. Gallery talk on Flow Visualization course, at the Boulder Museum of Contemporary Art, 4/27/04. Accompanied full exhibit of images from the course, from 3/12/2004 to 5/2/2004

J. Hertzberg and A. Sweetman, “Art and Physics: A Flow Visualization Course and Outreach Experience”. Invited paper, DH02, 2005 Winter Meeting of the American Association of Physics Teachers. Albuquerque, NM, January 8-12, 2005. Abstract published in *The Announcer*, Vol 34, pg 106.

"Teaching Flow Visualization: the Art and Physics of Fluid Flow" with Alex Sweetman. Invited talk, part of the CU Special Year in Art and Math. NCAR Mesa Laboratory, Feb 10, 2005

“A Course in Flow Visualization: the Art and Physics of Fluid Flow” Physics Education Research group meeting, Oct. 2005.

“Beautiful Physics From Ordinary Fluids” Guest lecture in MCEN 3021, 9/28/2006.

“Beautiful Physics From Ordinary Fluids” Sigma Xi invited talk, 11/6/2006.

“Beautiful Physics From Ordinary Fluids” TERC invited talk, 1/17/2007.

“Beautiful Physics From Ordinary Fluids” Applied Math Dept Seminar, CU Boulder, 2/16/2007.

“Beautiful Physics From Ordinary Fluids” Aerospace Engineering Dept Seminar, University of Washington, 3/5/2007.

“Beautiful Physics From Ordinary Fluids” Invited Seminar at University of Wyoming, Laramie, 3/6/2008.

“Introduction to Flow Visualization” Building Systems Seminar, CU Boulder 10/9/2008.

“Impact and Outcomes of a Flow Visualization Course” Physics Education Research group meeting, August 2009.

“Impact and Outcomes of a Flow Visualization Course” Fluids Connections (Dept. Mechanical Engineering, CU Boulder) group meeting, November 2010.

“Art for the Sake of Improving Engineering Education” CU Engineering Education Research Group meeting, November 2011.

“The Psychology of Praise”, Tau Beta Pi initiation dinner, 4/15/2012.

“The Aesthetics of Beauty, Power and Destruction,” APS DFD Special Session on Media Communications, San Diego, California USA, 18-Nov-2012

“The Aesthetics of Beauty, Power and Destruction.” Invited presented at the Water Resources Seminar, Department of Civil, Environmental and Architectural Engineering, Boulder, CO, January 16, 2013.

“Beauty, Power, Destruction and Oddness: The Aesthetics of Flow Visualization.” Seminar presented at the Fluids Seminar Series, University of Colorado, Boulder, September 3, 2013.

“Beauty, Power, Destruction and Oddness: The Aesthetics of Flow Visualization.” Seminar presented at the Engineering Education Research Group, University of Colorado, Boulder, September 17, 2013.

Current and Pending Support for Jean Hertzberg

Current

"The Power of Aesthetics" NSF RIGEE program. Hertzberg PI, Curran, Finkelstein, Ito Co-PIs. 01/01/2013 - 12/31/2014, $150,000.

4 Dimensional Cardiac MRI for the Diagnosis and Assessment of Pulmonary Hypertension. Butcher Seed Grant, two years beginning after formal award announcement in 2012. $100,000. Fenster PI, Hertzberg CoPI. 06/01/2012 – 5/31/2014.

CIRTL for the Nation. Border PI and Admin Leader, Hertzberg Co-PI and Academic Leader, subcontract from NSF via U. Wisc. 10% AY direct, 1 course buydown Grad School contribution. $200,000. 9/1/13 - 12/31/15.

Pending

None