

**2006-1690: HURRICANE KATRINA: A RESEARCH-BASED COURSE FOR  
ENGINEERING AND NON-ENGINEERING HONORS STUDENTS**

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# Hurricane Katrina: A Research-Based Course for Engineering and Non-Engineering Honors Students

## Introduction

Hurricanes Katrina and Rita damaged much of the civil infrastructure along the Gulf Coast, especially in the historic city of New Orleans. Reconstruction efforts and planning for future hurricanes in this region will fall on the shoulders of civil engineers. Most university students, even civil engineering students, do not understand the broad and complex role that civil engineers play in disaster planning and recovery efforts.

To this end, a research-based course entitled *Civil Engineering in the Wake of Katrina* is being taught during the Spring 2006 semester at the University of South Carolina. This course developed, in part, from the author's involvement with a service learning relief effort in Biloxi, MS to clean up after Hurricane Katrina<sup>1</sup>. The course was opened to both engineering and non-engineering students in the South Carolina Honors College. It is intended to 1) introduce the discipline of civil and environmental engineering to both engineering and non-engineering students, in light of conditions in the Gulf Coast before, during, and after Hurricane Katrina; and 2) provide a real hands-on research experience for exceptional students, which allows them to explore the many facets of civil and environmental engineering. It should be noted that this course is not an engineering course per se; rather, it is an honors proseminar taught by an engineering professor.

## Course Logistics

The South Carolina Honors College was founded in 1977 and is now recognized as one of the top honors programs in the country. The Honors College offers an enriched academic experience under the general rubric of Research Based Learning (RBL). The experience combines the benefits of a small liberal arts college with the opportunities of a comprehensive university. Like a liberal arts college, honors classes are limited in size and designed to involve students more actively in their own education.

This particular honors course was limited to 12 students for two reasons. First, the author wanted to ensure that each student had ample opportunities to actively participate in class discussions. Second, the author wanted to teach the course in a small, multimedia conference room instead of a traditional classroom. A total of ten students registered for the course, and the distribution of those students is shown in Table 1. Eight of the ten students are engineering students, and five of them are in the civil and environmental engineering program. The remaining two students are majoring in accounting and political science. It should be noted that one of the non-engineering students has an engineering background within his family. This student considered pursuing an engineering degree but chose to study political science. The other non-engineering student is from Kenner, LA, which is located just west of downtown New Orleans. His motivation for taking the course is an obvious one: to learn what it will take for New Orleans to recover and rebuild, and to see that through the eyes of engineering. His family was fortunate to survive with little damage to their home. However, his brother is an engineering student at Tulane University and was displaced for the fall semester.

**Table 1.** Distribution of Students

<b>Student</b>	<b>Declared Major</b>	<b>Academic Class</b>	<b>Gender</b>
1	Civil Engineering	Senior	Male
2	Civil Engineering	Senior	Male
3	Civil Engineering	Senior	Female
4	Civil Engineering	Junior	Male
5	Civil Engineering	Sophomore	Male
6	Chemical Engineering	Senior	Male
7	Chemical Engineering	Junior	Male
8	Chemical Engineering	Junior	Female
9	Accounting	Senior	Male
10	Political Science	Sophomore	Male

Based on past experiences, Honors College students prefer to be treated like graduate students. These students benefit most from courses that integrate free discussion with flexible approaches to topics. They prefer to be responsible for their own learning and to having instructors that are receptive to students' ideas for the course. With this in mind, the course was scheduled to meet once per week for two and a half hours using a graduate seminar format for instruction. In the course syllabus, the instructional format is described in this manner: "This course will be taught much more like a graduate course than an undergraduate course. It is expected that students will contribute their opinions to topical discussions freely and openly, be flexible with approaches to course topics, and be responsible for their own learning. The instructor is assuming the roles of course administrator, course facilitator, moderator and student, rather than simply as a teacher."

### **Course Objectives and Deliverables**

The instructor developed a set of course objectives and expected accomplishments, and the students were asked for input to refine them. The resulting objectives, as stated in the course syllabus, are given as follows:

"This course is expected to accomplish the following objectives: 1) introduce the discipline of civil and environmental engineering to both engineering and non-engineering students, in light of conditions in the Gulf Coast before, during, and after Hurricane Katrina; 2) provide open forum for discussion and debate on how government agencies and engineers should work together to protect the civil and social infrastructure of the United States against natural disasters; 3) provide hands-on research experience and develop research skills while exploring multiple facets of civil and environmental engineering; and 4) create service learning opportunities through a working relief effort in the Gulf Coast and/or with Hurricane Katrina evacuees in Columbia, South Carolina. It is probable, and encouraged, that other objectives will develop as the course evolves. Therefore students should be flexible and open to changes in the course content and objectives."

Assessing how well these objectives are met will also be challenging. This course is different from most undergraduate courses in that no written exams or quizzes will be administered to

assess student learning. Rather, students will be evaluated based on interaction and participation in topical discussions, the quality of completed assignments, and a set of three deliverables. It is expected that students will deliver the following products at the conclusion of this course: 1) a single, comprehensive web site; 2) a personal journal; and 3) contributions to at least one technical and/or educational paper to be presented and/or published in a conference proceedings or journal.

### **Instructional Materials**

Given the unique nature of this course and the fact that events are still unfolding in the aftermath of Hurricane Katrina, there are no required books or other instructional materials that students needed to purchase. Instead, the course relies heavily on textual and graphical information accessible via the web, and to a lesser degree, through print publications like newspapers, magazines and other periodicals like *ASCE News*. To this end, students were asked to locate informative web sites and compile a comprehensive list for posting on the course web site. A clear description of each web site was required along with its URL. To date, more than 50 web sites have been hyperlinked on the course web site. A representative sample of web sites identified and described by students is presented below.

<http://www.fema.gov/fima/>

This site is that of the Federal Emergency Management Agency's Mitigation Division. Its purpose is to propose regulations that can lessen the impact of national disasters such as Hurricane Katrina. One of the major lessons learned from Hurricane Katrina will be to increase awareness of the importance of flood insurance as well as improving building codes. It is the mission of the Mitigation Division to decrease the likelihood of damage before a disaster occurs.

[http://news.nationalgeographic.com/news/2005/02/0209\\_050209\\_wetlands.html](http://news.nationalgeographic.com/news/2005/02/0209_050209_wetlands.html)

This pre-Katrina article does a good job of describing the effects of wetland destruction and the increased flooding it causes. Many of these predictions came true a few months later when Hurricane Katrina hit, greatly damaging the oil, shipping, and fishing industries to name a few. This article also explains some of the many factors that have contributed to wetland destruction.

[http://www.businessweek.com/bwdaily/dnflash/sep2005/nf2005097\\_3393\\_db035.htm](http://www.businessweek.com/bwdaily/dnflash/sep2005/nf2005097_3393_db035.htm)

This is an article about how Hurricane Katrina had an unusual economic impact, as hurricane impacts go, because of particular circumstances such as oil production and the location of the Mississippi River.

<http://news.bbc.co.uk/2/hi/science/nature/4223426.stm>

The water that had lain stagnant on the streets of New Orleans has been contaminated with urban waste such as oil and gasoline. Previously the water collected in New Orleans has been cleaned and then pumped into Lake Pontchartrain. Due to the contaminants, scientists are worried that pumping the untreated water into the lake will damage the natural wildlife since the treatment plants used to clean the water are not operational. Scientists from LSU are currently monitoring the current toxins level in the lake to see how they change with time. In the past it was not uncommon for the lake to receive waste from New Orleans, but recent measures have been undertaken to stop this pollution. Beyond the threat of pollution from the city, ecological

damage also impacted the lake. The lake had an influx of salt water drastically increasing the sensitive salt levels. The article concludes with a comment on the impact that global warming might have played on the development of this powerful hurricane.

<http://www.reconstructionwatch.org/>

This website was founded in the wake of Hurricane Katrina by the Institute for Southern Studies and seeks to provide a more democratic and accountable reconstruction of the Gulf Coast. It aims to document and investigate the rebuilding of New Orleans and other coastal cities impacted by the hurricane “through original reporting, in-depth features, voices from community leaders, and other unique coverage.”

In addition to web-based information, the course intends to use technical publications pending their availability. However, most journal publications and conference proceedings related to research on Hurricane Katrina will not be published during the timeframe of this course. Diaz published an editorial on lessons learned from Hurricane Katrina<sup>2</sup>, and that article was distributed and discussed in class. The lack of refereed technical publications at the present time further emphasizes the importance of using web-based materials.

In the six months since Hurricane Katrina hit the Gulf Coast, a small number of documentaries on different aspects of the disaster have been published through public television. To date, all of the published videos have been acquired for the course and include:

- **Hurricane Katrina: The Storm that Drowned a City**, Pioneer Production for NOVA in association with WGBH/Boston, 2005, 56 minutes;
- **The Storm**, Frontline co-production with RAINmedia Inc., Distributed by PBS Home Video, 2005, 60 minutes;
- **NOW Hosted by David Brancaccio**, *Losing Ground*, Episode NOWD6135, JumpStart Productions, LLC, Distributed by PBS Home Video, September 2, 2005, 30 minutes;
- **NOW Hosted by David Brancaccio**, *Race, Class, and Katrina*, Episode NOWD6136, JumpStart Productions, LLC, Distributed by PBS Home Video, September 9, 2005, 30 minutes;
- **NOW Hosted by David Brancaccio**, *Katrina: The Response*, Episode NOWD6137, JumpStart Productions, LLC, Distributed by PBS Home Video, September 16, 2005, 60 minutes;
- **NOW Hosted by David Brancaccio**, *In Harm's Way*, Episode NOWD6138, JumpStart Productions, LLC, Distributed by PBS Home Video, September 23, 2005, 30 minutes; and
- **NOW Hosted by David Brancaccio**, *Disaster Agency*, Episode NOWD6139, JumpStart Productions, LLC, Distributed by PBS Home Video, September 30, 2005, 30 minutes.

Two other videos were acquired for the course, including one on the mechanics of hurricanes and another on the history of levee construction along the Mississippi River:

- **Hurricane! Fly into the eye of one of the worst hurricanes ever**, Production of BBC-TV in association with WGBH for NOVA, 1989/2004, 60 minutes; and

- **A Tale of Two Rivers**, *Great Projects: The Building of America Series*, Production of Great Projects Film Company, Inc. in association with South Carolina ETV and the National Academy of Engineering, Distributed by PBS Home Video, 2002, 60 minutes.

## **Student Questions Regarding Hurricane Katrina**

As part of another assignment, each student was asked to pose three questions that warrant discussion in this course, which created an aggregate of 29 questions. Each student was encouraged to consider both engineering and non-engineering issues that are of personal interest. These 29 questions were compiled and organized by the instructor into eight general categories: government response and responsibility (6 questions); human and social impacts (3); wetlands (3); levees and flood protection (5); building codes (2); reconstruction (4); education (1); and preparation for the next one (5). This was an important assignment in that it provides significant insight into what students truly want to learn from this course. The unedited questions are summarized below.

### Government Response and Responsibility: Pre- and Post-Hurricane

- People have talked about "the big one" hitting New Orleans for awhile now. What type of emergency plan did they have, and where did it fail? Did they have a "Worst Case Scenario" and a plan of action for it?
- Why was the response so slow by the government?
- What mistakes were made by the government on all levels? Should/could the evacuation have come sooner and who should have had the authority? Was a lack of funding an issue? Did bureaucracy slow down the response process? Who should take charge in a situation like this?
- In light of the unpredictability of hurricanes and cost of evacuations, how should emergency planners coordinate evacuations? Should the federal government be involved, and who should pay for it?
- Should the government give money to citizens for individual property loss?
- Should a hurricane be a local or federal issue?

### Human and Social Impacts

- Why did the citizens of New Orleans go crazy after the hurricane (i.e. looting)?
- How did the majority of deaths occur as a result of Hurricane Katrina? Did most of the deaths result from drowning, injuries sustained as a direct result of the wind speeds of the hurricane, or due to heat exposure in the days following the hurricane?
- When the 9/11 terrorist attacks occurred, it seemed that everyone was trying to step up (President Bush, Mayor Giuliani, the American people, etc.), however it didn't seem to me that this occurred to the same extent after Katrina. There was a lot of blaming going on about who messed up and why it was someone else's mishap that caused the failures that occurred. Why is that?

### Wetlands

- What can be done to restore the wetlands in the Gulf Coast?
- How can the wetlands and barrier islands in Mississippi and Louisiana be reclaimed?
- Why has the wetland issue been so ignored for so long?

### Levees and Flood Protection

- What are the specific types of hydrological structures that can be used as levees? What makes some better than others? What other structures could be used? Who decided what the design standards were for the levee system and the overall flood protection system?
- How did they arrive at these standards (empirical)?
- How exactly did the levee system malfunction and what can be done to improve the levee system / flood protection system in New Orleans?
- Why does New Orleans have such an outdated protection system (i.e. levees), and why wasn't something done a long time ago to update them?
- Is it possible to make New Orleans 100% safe from the massive flooding caused by hurricanes such as Katrina?

### Building Codes

- What types of building codes were in place, how well were they followed, why did the structures fail and which codes should have been stronger to lessen the structural damage that occurred?
- Are the building codes in coastal areas regarding hurricane standards taking into account more risks from wind damage or water damage? Should codes be revised to be more focused on risks posed by storm surge or those posed by wind strength?

### Reconstruction

- Should the city be rebuilt?
- With the rebuilding of New Orleans, what structural improvements are being made to prevent this from happening again?
- In rebuilding New Orleans and the Gulf Coast, will the majority of structures be renovation projects or new construction? On the webpage that Mark sent out regarding how the \$85 billion is being spent, an ad on the side of the page advertised a high-rise condominium project in downtown New Orleans and emphasizes that it is new construction. Is it really necessary to replace old structures sustaining damage in New Orleans or is it more economical to renovate existing structures that have been damaged?
- What engineering solutions can be used to lessen the impact to the basic safety of residents and lessen the physical damage from wind and rain to structures?

### Education

- What programs are currently in place to educate/prepare residents to protect themselves from hurricanes, both before and during a storm, and what programs could be put in place in the future?

### Preparation for the Next One

- With what we now know (and have experienced), what needs to be changed? And, does this show any sort of incompetence or negligence, or was it merely an unforeseeable event, or unfeasible to compensate for budget-wise?
- How can we better prepare for a hurricane learning from the destruction of Hurricane Katrina, like better infrastructure and/or better hurricane predictions and (mandatory) evacuations?

- In the way of preparation for future events such as this one, how much physical preparation is reasonable (levees, hurricane resistant construction) and how much is a waste of money that could otherwise be spent on preparation such as evacuation routes, educating residents, etc.?
- How do cities/countries around the world deal with similar situations and what can we learn from them (wetland protection; protective dunes, dikes, levees, gates, etc.; building construction)?
- How can we efficiently respond to a hurricane after it has destroyed a region so tragically?

## Course Modules

Finally, a set of course modules was developed based on the course objectives, instructional materials, and student interests. By completing these modules, the class as a whole should achieve the course objectives and, in doing so, should answer the 29 questions about Hurricane Katrina. The class meets over 14 weekly sessions. Each week has been divided into a module, although each module retains some flexibility. The order of modules may also change as the course progresses. Each module is presented below in the expected chronological order.

Week 1: Hurricanes – basics of how hurricanes form, move, and dissipate; history of hurricanes in the United States and, specifically, in the Gulf Coast; presentation and discussion of Hurricane Katrina

Week 2: Understanding New Orleans – geography and geology of New Orleans and the Gulf Coast region; review of the U.S. Army Corps of Engineers levee system along the Mississippi River; exploration of soil deposits in New Orleans using NCSS Web Soil Survey 1.0 (<http://websoilsurvey.nrcs.usda.gov/app/>)

Week 3: Evacuation Planning – a charette conducted in two groups to plan and manage a hurricane evacuation in New Orleans; evacuation plans reviewed by local officials from the South Carolina Emergency Management Division and South Carolina Department of Transportation

Week 4: Disaster Relief – discussion of roles of federal agencies like DHS and FEMA and non-profit organizations like American Red Cross and Salvation Army; visit to Salvation Army offices in Columbia, SC to discuss how disaster relief efforts are conducted and coordinated

Week 5: Wind Damage – build and test model structures in a wind tunnel

Week 6: Water Damage – work with numerical and physical models of the levee failures in New Orleans (models are under development as part of a research grant to a colleague at the University of South Carolina)

Week 7: Water Damage – understanding flood maps, flood insurance, and drainage; discussion with a local practicing engineer who specializes in hazard assessment



Week 8: Damage Assessment in Biloxi, MS – prepare a damage map for parts of Biloxi and create a photographic archive of the damage, using observational data collected by the instructor and other university students in October as part of a service learning relief effort

Week 9: Disease and Ecological Impacts – presentation from CDC and discussion of the “toxic soup” problem in New Orleans and the extent of ecological damage along the Gulf Coast

Week 10: Clean Up – disposal issues with hazardous and non-hazardous materials; landfill management of large volumes of debris; discussion on concept of recycling demolition debris

Week 11: Reconstruction – interactive discussion on how New Orleans should or should not be rebuilt and how it should be organized and financed

Week 12-14: Open – topics will be added as the course progresses

During a four-day period in March, students will also travel to Biloxi, MS and New Orleans, LA to assist in recovery efforts and collect observational damage data. This service and research trip is required for all students. It is expected that experiences from this trip will lead to the creation of new modules that can be covered during the three open weeks at the end of the course.

### **Course Assessment**

Since the course is now in progress, it is difficult to make a final assessment at this time. However, a comprehensive assessment of course objectives will be conducted upon its completion. There are multiple expected outcomes of this course. Students are expected to: gain awareness and knowledge of the civil engineering profession; develop an understanding of the impacts of natural disasters on the infrastructure, the environment, the economy, and society as a whole; gain service learning experience by assisting recovery efforts in the Gulf Coast; and develop research skills by participating in hurricane damage assessment studies and contributing to a research paper(s). Appropriate assessment instruments, including an exit survey, will be developed to measure each of these expected outcomes.

It is anticipated that this course will serve as a model for the development and instruction of other “outreach” engineering courses for engineering and non-engineering students alike. It is rare for a non-engineering student to enroll in an engineering course, but that can change by creating and teaching courses like this one. Although disasters like Hurricane Katrina are devastating, they also provide engineering educational opportunities that should not be missed.

### **References**

1. Pierce, C.E. and Bolton, C.B. (2006) “Student Service Learning in the Wake of Katrina,” *113<sup>th</sup> Annual ASEE Conference & Exposition*, Chicago, IL, pp. 1-10.
2. Diaz, L.F. (2005) “Natural Disasters: Lessons Learned from Katrina,” *Waste Management*, Elsevier Ltd., Vol. 26, pp. 1-2.