<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highlights 1998-1999</td>
<td>1</td>
</tr>
<tr>
<td>Promotional and Professional Activities</td>
<td>3</td>
</tr>
<tr>
<td>Public Outreach</td>
<td>3</td>
</tr>
<tr>
<td>Professional Activities</td>
<td>10</td>
</tr>
<tr>
<td>Visiting Scholars and Dignitaries</td>
<td>15</td>
</tr>
<tr>
<td>Research Projects</td>
<td>16</td>
</tr>
<tr>
<td>Publications and Reports from WERC Projects</td>
<td>26</td>
</tr>
<tr>
<td>Wind Engineering Personnel</td>
<td>33</td>
</tr>
<tr>
<td>Theses/Dissertations Completed</td>
<td>36</td>
</tr>
<tr>
<td>Proposals Submitted</td>
<td>39</td>
</tr>
</tbody>
</table>
HIGHLIGHTS 1998-1999

The Wind Engineering Research Center (WERC) was established by action of the Board of Regents at Texas Tech University in September 1988. The Center's objectives are to promote multidisciplinary research in wind engineering, to attract external funding for wind engineering research, to provide a forum for faculty and students from various disciplines to work as a team and to provide information and materials to the public through its outreach program. The Center continues to pursue these objectives with measurable success.

Highlights of wind engineering activities during 1998-99 are as follows:

• 17 funded wind engineering-related research projects were pursued during the year. Some of these projects have commitments to continue over the next few years.

• 28 faculty members representing 10 academic departments and 11 research associates are currently pursuing wind engineering-related research.

• 43 graduate students pursued wind engineering-related research; 6 completed M.S. degrees and 1 completed Ph.D. degrees during the year. Additionally, 51 undergraduate students were involved in various wind engineering projects.

• Research was supported by $4,418,345 in external funds ($4,404,345 in governmental grants and $14,000 in contracts from the private sector) and $282,000 in internal funding totaling over $4.6 million.

• WISE was awarded funding by the federal legislature. Funding of $3.6 million for 98-99 and $1.1 million for 99-00 is administered through a cooperative agreement with the National Institute of Standards and Technology (NIST). A team of sixteen faculty members from the disciplines of civil and chemical engineering, architecture, atmospheric science, mathematics and economics has been assembled to pursue research and technology transfer activities in seven interrelated research thrust (RT) areas. An Information/Outreach Center has also been established under the program. This funding will extend into next fiscal year.

• 17 publications in refereed journals and 45 publications in proceedings of conferences and reports have resulted this year from research projects.

• 20 proposals were submitted for over $5.6 million.

• Successful deployment of mobile instrumented tower (WEMITE) for Hurricanes Bret and Dennis before the end of August 1999.

• Damage investigation teams were dispatched following
  - Oklahoma City tornado, Oklahoma City, OK, Anna Gardner, Tim Marshall, Larry Tanner team leaders, Mark Conder, Rob Howard, Mark Martinez, Steve Weinbeck and Eric Wesley, 5-6 May, 1999. Larry Tanner returned as part of FEMA’s Building Performance Assessment Team (BPAT) to investigate tornadoes in Oklahoma and Wichita, KS, 10-17 May, 1999.
• WISE submitted a request to host the next (2003) meeting of the International Conference of Wind Engineering. The proposal was accepted and Dr. Mehta named Chairman of the International Association for Wind Engineering for a four-year term.

• Over 120,000 copies of the FEMA booklet, *Taking Shelter from the Storm: Building a Safe Room Inside Your House*, have been distributed. The booklet is available from FEMA Publications as #320 by calling 1-888-565-3896.

• A short course, *Engineering for Extreme Winds*, was offered to practicing professionals in February 1999.

• An exhibit, *Winds of Destruction, Currents of Change*, continues at the Science Spectrum in Lubbock. An interactive exhibit on wind at the Lakeview Museum of Arts and Sciences, Peoria, IL, includes photographs from WERC. A house model showing an in-residence shelter is part of a nationwide museum tour organized by the Franklin Museum, Philadelphia, PA.
PUBLIC OUTREACH

Tours/Presentations for Schools/Civic Groups
Presentation on the “Wind Science and Engineering Center at TTU,” to the Lubbock Rotary, Dr. Peterson, September 28, 1998.
Presentation on In-residence shelters, the Wind Engineering missile testing program and identification of occupant-protective areas to the Tahoka Rotary, R Carter, October 20, 1998, 36 attendees.
Presentation on wind engineering, Lubbock Rotary Club, Dr. D Smith, October 30, 1998.
Teacher’s workshop, Educational Service Center, February 15, 1999, 22 participants.
Science Day presentation on tornadoes, Dr. McDonald, February 20, 1999, 30 participants.
Presentation on in-residence shelters, L Tanner, Groves library, February 22, 1999, 10 participants.
Severe Weather Awareness Day, Reese Center, exhibits on Damage Investigation, Storm Intercept Team, Mesonet, Wind tunnel, In-residence shelters and WEMITE from WERC; National Weather Service; American Red Cross; NewsChannel 11 Weather team and Smokey the Bear as well as science experiments and a tornado puzzle for the children. Demonstrations of the mini-missile launcher, mini-wind tunnel and tornado simulator, 30 volunteers, 70 visitors, February 27, 1999.
Presentation to Clinical Pathology Dept., Health Sciences Center, Texas Tech Univ., L Tanner, 22 participants, March 11, 1999.
Presentation on in-residence shelters by Dr. Kiesling, Lubbock Home show, 28 participants; Wind Engineering had a small display on shelters at the home show as well, March 13, 1999.
Presentation on safe room program by Dr. Kiesling, Hurricane Task Force for the Lee Building Industry Association, March 15, 1999.
Exhibit on Wind Engineering/National Institute of Standards and Technology Cooperative Agreement for a Windstorm Mitigation Initiative and in-residence shelter, National Hurricane Conference, Tallahassee, FL, March 31-April 1, 1999.
Exhibit on in-residence shelter for 20th tornado anniversary event, Wichita Falls, 1500 participants, E Johnston Vasquez and A MacDowell, April 10, 1999.
Tour of WERFL by T Rodriguez and A MacDowell for Lubbock High Storm Chase class, May 7, 1999, 35 participants.
Workshop on in-residence shelters for builders and public by Dr. Kiesling, sponsored by FEMA, Wichita, KS, May 21, 1999, 45 participants.
Workshops (2) on in-residence shelter construction by Dr. Kiesling, sponsored by FEMA, DeKalb, TX, June 1, 45 participants.
Dedication of shelters, public workshop (200 participants) and builders workshop (85 participants) on in-residence shelters by Dr. Kiesling, sponsored by FEMA Project Impact, State Farm Insurance and the City of Tulsa, June 2-3, 1999.
Presentation on in-residence shelters and tornado safety by L Tanner, RV owners, KOA, Lubbock, TX, 40 participants, June 9, 1999.
Presentation on in-residence shelters by Dr. Kiesling, Levelland Rotary Club, 15 participants, June 11, 1999.
Presentation to 5th gr class, Wheatley Elem, by A MacDowell June 13, 1999, 25 participants.
Tour of WERFL by T Rodriguez and A MacDowell for Wheatley Elem, June 19, 1999, 25 participants.
Presentation on in-residence shelters by L Tanner, Lubbock Rotary, June 22, 1999, 45 participants.
Presentation on in-residence shelters by L Tanner, Lamesa Kiwanas, 35 participants, July 6, 1999.
Presentation on in-residence shelters by L Tanner, Levelland Rotary, 45 participants, July 13, 1999.
Presentation and exhibit on in-residence shelters by L Tanner, Ouachita Parish, LA, sponsored by Ouchita Civil Defense Agency, July 20, 175 participants for presentation, 400 for exhibit.
Tour of Wind Engineering, wind tunnel and WERFL for students in Education class, August 2, 1999, 15 participants.
Workshop on in-residence shelters by Dr. Kiesling, Wichita, KS, August 28, 30 participants.

Popular Print Media
“Tech moves closer to Carnegie I goal,” Lubbock Avalanche-Journal, mentioned WERC’s contribution to the goal for Research I status and interviewed Dr. Mehta regarding research funding, September 4, 1998.
“Congress marks $8 million for Tech research,” Lubbock Avalanche-Journal, includes information on a $1.2 million appropriation for Wind Engineering.
A Scripps Howard newswriter in NY interviewed Dr. Peterson for 45 minutes on hurricanes.
“Shelter from the storm: Tornado-proof rooms that are designed to save lives,” Fine Homebuilding, January 1999.
“Tulsa pioneers building tornado-safe room,” Tulsa Partners described the in-residence shelter and efforts on the part of Tulsa, Oklahoma’s Project Impact program to publicize the concept. They interviewed Dr. Kiesling during a scheduled news conference, January 1999.
“Tech, Reese agency lay out vision for research park,” Lubbock Avalanche-Journal, included mention of WERC and a photograph of the missile launcher in an article on Reese redevelopment, February 27, 1999.
“Shelter in a time of storm,” The Morning Journal, Lisbon OH, mentioned the FEMA booklet and research by WERC in shelter design as part of “Spring Weather Can Spin Off Twists and Turns,” a Newspapers in Education page, March 9, 1999.
“Ready for disaster: ’70 tornado prepared city to handle problems on wide scale,” included an interview with Dr. McDonald regarding the city’s disaster plan in 1970, Lubbock Avalanche-Journal, March 12, 1999.
“Lubbock, Tech gaining ground as weather, wind research centers,” Lubbock Avalanche-Journal interviewed Dr. Peterson regarding current and future research, April 2, 1999.
“$2 million approved for Tech wind research,” The University Daily, Lubbock, TX, interviewed Drs. Doggett and Mehta regarding the mesonet project, April 23, 1999.
“Real World,” *Graduating Engineer and Computer Careers*, the issue highlighted four engineering programs which provide practical experience to their students. The Wind Engineering program was one of the featured programs, April 1999.

*The Houston Chronicle* interviewed Dr. D Smith regarding performance of buildings and mobile homes in tornadoes and the Fujita scale and Dr. Kiesling regarding shelters, May 5, 1999.

“Tech wind researchers head to OKC,” *The University Daily* interviewed Dr. Peterson regarding the damage investigation team, May 5, 1999.

“Texas Tech professor studies hail damage,” *The University Daily* interviewed Dr. M Smith regarding the hail gun and research on hail damage, May 5, 1999.

*The Chicago Tribune* spoke to Dr. Mehta regarding water towers in tornadoes, May 6, 1999.

“Researching tornadoes: Storm students hope to learn from Oklahoma,” *San Angelo Standard-Times*, covered WERC’s damage investigation in OKC interviewing S Weinbeck and L Tanner and interviewed Dr. Kiesling regarding shelter design, May 6, 1999.

“In-home storm shelter survives the real thing,” *The Wichita Eagle-Beacon* described the Bartlett shelter and shelter research at Texas Tech and interviewed L Tanner in OKC, May 7, 1999.

*Fort-Worth Star Telegram* interviewed L Tanner in OKC at the site of the above-ground shelter, May 7, 1999.


The Associate Press interviewed L Tanner in OKC at the site of the above-ground shelter, May 7, 1999.


“Tornadoes’ unexpected windfall,” *USA Today*, mentioned damage investigation by TTU after the Oklahoma tornadoes, May 14, 1999.

The lead article in *Home on the Plains*, vol 2, no. 5, a newsletter from the Kansas HUD office discussed in-residence shelters, May 14, 1999.


*The Texarkana Gazette* interviewed Dr. Kiesling in DeKalb, TX, regarding the in-residence shelter, June 1, 1999.

*The Oklahoman*, Oklahoma City, OK, interviewed Dr. Kiesling regarding the in-residence shelter and the workshops held in Tulsa, June 3, 1999.

*Tulsa World Herald* interviewed Dr. Peterson regarding severe storms and global warming, June 3, 1999

*The Washington Post* interviewed Dr. Peterson regarding dust in West Texas for an article on George Bush, June 17, 1999.

“Shelter in a storm,” *Dallas Morning News* interviewed L Tanner, Beth Bartlett of Dell City, OK, whose above-ground shelter was in the tornado of May 3, Kevin Daves of Wichita, KS, who has built a subdivision of homes all with in-residence shelters and David Hentges of Lubbock who has a shelter in his home, June 25, 1999.

“CMU and high winds,” *Concrete Masonry*, an editorial by Dr. Mehta on use of reinforced CMU for wind resistance, July, 1999.

“Withstanding the storm,” *Concrete Masonry* interviewed L Tanner and discussed WERC’s research on using reinforced CMU for safe room construction, July 1999.
"Should you add a safe room to your home," *USAA Magazine*, featured the safe room and mentioned research by Texas Tech and, on February 25, interviewed Dr. Kiesling, L Tanner and R Carter and took photographs of the missile cannon for this article, appeared June/July 1999.

"Fund wind research," an editorial in the *Lubbock Avalanche-Journal*, discussed funding for WERC and expressed the opinion that WERC should receive more than was allocated by the congress, August 13, 1999.

"Safe rooms starting to catch on: Some residents build homes with storms in mind," *Florida Today*, noted the research of WERC on in-residence shelters and interviewed L Tanner beforehand, August 14, 1999.


"Storm-chasers get set for action," *Savannah Morning News* interviewed T Rodriguez and R Howard and discussed the WEMITE research program as the WEMITE team deployed for Hurricane Dennis, August 29, 1999.

"Coastal currents: Tech research teams put themselves in path of Hurricane Dennis for study," *University Daily*, Lubbock, TX interviewed J Schroeder, S Hutchinson, S Balcar, S Weinbeck and R Howard.

The article discussed the WEMITE project and imminent deployment to the Carolinas for Hurricane Dennis, August 30, 1999.

**Visual/Auditory Media**

Little Rock, AR, Scottie Goodman interviewed Dr. Kiesling and filmed a missile shot for a news program, September, 1998.

KCBD-TV, Channel 11, Lubbock interviewed Dr. Peterson regarding the activities of the WEMITE team and possible future plans related to Hurricane Georges, September 28, 1998.

**Discovery Channel, Canada interviewed Dr. Mehta for an 8-minute segment, September 29, 1998.**

KTVT-TV, Channel 11 news, Dallas, TX interviewed Drs. Sarkar, Oler and Kiesling, J Schroeder and T Gardner. They filmed a model of a commercial building in the wind tunnel, the missile launcher and setting up of the mobile tower (WEMITE), October 28, 1998.


**Discovery Channel, Canada, producing a series entitled “Storm Warning,” requested a variety of information and video of the wind tunnel, November 11, 1998.**

WTHR-TV, NBC affiliate, Indianapolis, IN interviewed R Carter who described the missile launcher and in-residence shelter and Dr. Oler who described the wind tunnel. Filmed missile launcher and building model in wind tunnel, January 21, 1999 for news series to air in early March, 1999

**“Storm Force” a series shown in Britain to 2.6 million people and broadcast in the U.S. on the TLC channel included a segment on the missile launcher, January 4, 1999.**


KLBJ-TV, Lubbock, TX interviewed Dr. McDonald on the “Live at 5” program regarding what has been learned from damage investigation, January 22, 1999.

WREG-TV, Memphis, TN interviewed Dr. Kiesling, Dr. M Smith and J Snelson and filmed the missile launcher, WERFL and hail gun, February 2, 1999.

WXIA-TV, Atlanta, GA featured video of the missile launcher, February 20, 1999.
KATV-TV, Little Rock, AR filmed the wind tunnel, WEMITE, missile launcher and field site and interviewed Dr. Kiesling, R Carter and T Rodriguez for a special news segment, February 18, 1999; aired March 1 and 2, 1999.

"Disaster," a segment for Dream Builders on Home and Garden Television, featured the missile launcher, interviews with Dr. Kiesling and with Susan and Fred Morris, homeowners who included a storm shelter in their new home, aired January 1999.

KLBK-TV, Lubbock, TX interviewed L Tanner and filmed his presentation on shelters at Groves public library, February 22, 1999.

KCBD-TV, Lubbock, TX mentioned the Severe Weather Awareness Day activities, February 22, 1999.

KCBD-TV, Lubbock, TX filmed the WEMITE tower and interviewed T Rodriguez about WEMITE and the field site, February 25, 1999.

KMAC-TV, Lubbock, TX filmed the missile launcher and interviewed R Carter about the in-residence shelter, February 25, 1999.

KCBD-TV filmed Severe Weather Awareness Day activities, February 27, 1999.

Initial meeting with Alec Nesbitt and Jennifer Sellar of Pioneer Productions regarding possible filming in future for a series to be shown in the UK and in the US on the Learning Channel, Drs. Mehta, McDonald, Kiesling, Sarkar and Haragan and R Carter, March 15, 1999.

WINK-TV, Fort Meyers, FL, interviewed Dr. Kiesling about the in-residence shelter during the Homebuilders Parade of Homes, March 22, 1999.

BBC, England, filmed the missile launcher, hail cannon and wind tunnel and interviewed Dr. Kiesling and Dr. M Smith. They filmed various objects projected at the targets, such as a tree limb and brick. Dr. M Smith demonstrated the hail cannon which was used to shoot ice balls at a car windshield (still on the car) and a car hood (not on the car). Dr. Sarkar demonstrated the wind tunnel with a model to show wind effect on a roof, March 26, 1999.

Hurricane X, a special for the Discovery Channel, interviewed Dr. Mehta at the Hurricane Conference, Orlando, FL, April 1, 1999. Video Services also sent copies of videos of the wind facilities.

KFDX-TV, Wichita Falls, TX interviewed Dr. Kiesling and filmed the missile launcher, aired April 9, 1999.

CNN filmed the missile launcher and interviewed Dr. Kiesling and R Carter, discussed the in-residence shelter and FEMA booklet, also showed footage of the Hentges of Lubbock who built an in-residence shelter in their home, March 8, aired April 9 & 10, 1999 on CNN Today, CNN Morning News, Showbiz Today, Headline News and Business Unusual.

The following stations aired the CNN video and interview: WFLA-TV, Tampa/St. Petersburg, FL; WTHR-TV, Indianapolis, IN; KTIV-TV, St. Louis, MO; WFXT-TV, Boston, MA; WAGA-TV, Atlanta, GA; KABB-TV, San Antonio, TX; WTAE-TV, Pittsburgh, PA; WITI-TV, Milwaukee, WI; WDAF-TV, Kansas City, KS; KSDK-TV, St. Louis, MO; WPXI-TV, Pittsburgh, PA; KSDK-TV, WLWT-TV, Cincinnati, OH; and WTXF-TV, Philadelphia, PA, April 9 & 10, 1999.

WOWT-TV, Omaha, NE showed footage of the missile cannon and discussed the in-residence shelter, April 28, 1999.

KLBK-TV, Lubbock, TX interviewed P Nash and Dr. Giesselmann regarding the wind farm and wind energy on the South Plains, April 14, 1999.

KCBD-TV, Lubbock, TX showed an interview with Dr. Kiesling regarding the in-residence shelter and spoke to the Hentges who have an in-residence shelter in their home, April 15, 1999.

WBNS-TV, Columbus, OH, discussed development of the in-residence shelter by WERC, April 16, 1999.
Channel 6, City of Lubbock's TV channel, featured a 15-minute program with Drs. Peterson and D. Smith regarding planned research for Reese Center, filmed April 20, 1999 to be shown periodically over the next month.

The Wind Engineering Research Center is featured on a promotional video on Lubbock produced by the City of Lubbock for distribution, April 21, 1999.

Ag Day, discussed testing conducted by WERC on insulating concrete form (ICF) walls, April 22, 1999. WWL-TV, New Orleans, LA, featured an interview with Dr. Kiesling and missile shot, April 28, 1999.

WCBO-TV, Cincinnati, OH meteorologist P Delkus interviewed Drs. Mehta and Kiesling, T Gardner and S Balcar and filmed the missile launcher, wind tunnel model of a commercial building of a cable-stay, which is part of a research project for TxDOT, and the field site, April 30, 1999.

KWES-TV, Midland, TX, spoke with Drs. Kiesling and Sarkar, L Tanner and T Gardner and filmed the missile launcher and field site, April 27, 1999.

KCBSD-TV interviewed Dr. Kiesling and C Compañy regarding the damage investigation team sent to Oklahoma City, May 4, 1999.

KMABC-TV interviewed Dr. Kiesling and C Compañy regarding the damage investigation team sent to Oklahoma City, May 4, 1999.

WBZL-TV, Miami, FL, featured an interview with Dr. Kiesling and video of the missile launcher, May 4, 1999.

KDAF-TV, Dallas, Fort Worth, TX, featured an interview with Dr. Kiesling and video of the missile launcher, May 4, 1999.

**Extra: The Entertainment Magazine, interviewed Dr. McDonald about the shelter, showed a demonstration of the missile launcher and discussed the FEMA booklet, May 4, 1999.**

KMABC-TV, Lubbock, TX, interviewed Dr. Gill regarding the dust storm in Lubbock, May 4, 1999.

WTWJ-TV, Miami, FL, showed an interview with Dr. Kiesling and missile testing and discussed the in-residence shelter, May 5, 1999.

KMABC-TV, Lubbock, TX, interviewed L Tanner in Oklahoma City, OK (OKC) regarding damage investigation, May 5, 1999.

KLBBK-TV, Lubbock, TX, interviewed A Gardner in OKC regarding damage investigation, May 5, 1999.

NBC-Dateline showed a re-edited version of the missile launcher segment including an interview with Dr. Kiesling and mentioned the damage investigation teams in OKC, May 5, 1999.

KTVJ-TV, Miami, FL, showed an interview with Dr. Kiesling and missile testing and discussed the in-residence shelter, May 5, 1999.

KXAS-TV, Dallas/Fort Worth, TX discussed the in-residence shelter and showed the missile launcher, May 5, 1999.

WTHR-TV, Indianapolis, IN interviewed R Carter about damage caused by tornadoes, and featured the missile launcher and wind tunnel, May 5, 1999.

**CBS This Morning included a live missile shot and interview with Dr. Kiesling regarding the in-residence shelter. They also showed tape of another missile shot and a model in the wind tunnel, May 6, 1999.**

The World Today, CNN, interviewed L Tanner in OKC at the site of the above-ground shelter which survived the tornado, May 6, 1999.

KABB-TV, San Antonio, interviewed L Tanner in OKC at the site of the above-ground shelter which survived the tornado and discussed the FEMA publication, May 6, 1999.

KOKH-TV, Oklahoma City, OK interviewed L Tanner in OKC at the site of the above-ground shelter which survived the tornado, May 6, 1999.

KRRT-TV, San Antonio, TX interviewed L Tanner in OKC at the site of the above-ground shelter and discussed the FEMA booklet, May 6, 1999.
KOCO-TV, San Antonio, TX interviewed L Tanner in OKC at the site of the above-ground shelter, May 6, 1999.

KXAN-TV, Austin, TX, interviewed L Tanner in OKC at the site of the above-ground shelter, May 6, 1999.

KFOR-TV, El-Paso, TX, interviewed L Tanner in OKC at the site of the above-ground shelter, May 6, 1999.

All News Channel filmed the damage investigation team in OKC, May 6, 1999.

TSN (Texas State Network) radio interviewed L Tanner in OKC at the site of the above-ground shelter, May 6, 1999.

WTIC, Hartford, CN broadcasts a radio call-in show, Dr. Doggett spoke regarding new technology for tornado detection, May 7, 1999.

**Early Edition, CNN interviewed L Tanner in OKC at the site of the above-ground shelter, May 7, 1999.**

KDFW-TV, Dallas, TX, discussed shelter research with the damage investigation team at the site of the above-ground shelter, May 7, 1999.

KVUE-TV, Austin, TX interviewed L Tanner in OKC at the site of the above-ground shelter, May 7, 1999.

KENS-TV, San Antonio, TX, discussed the shelter research at Texas Tech and filmed the damage investigation team in Oklahoma City, OK, May 9, 1999.

KPRC-TV, Houston, TX, news discussed the in-residence shelter, May 13, 1999.

KVII-TV, Amarillo, TX, interviewed R Carter regarding the in-residence shelter and damage investigation research at WERC and taped the missile launcher, May 21, 1999.

KICT Radio, Wichita, KS, interviewed Dr. Kiesling regarding the in-residence shelter, May 21, 1999.

KWCH-TV, Kansas Broadcasting System, interviewed Dr. Kiesling regarding the in-residence shelter, May 21, 1999.

KXAN-TV news, Austin, TX, discussed the in-residence shelter, May 27, 1999.

*Nature’s Wrath III, Discovery Channel, described the in-residence shelter, May 30, 1999.*

KSCA-TV, Shreveport, LA, interviewed Dr. Kiesling regarding the in-residence shelter in DeKalb, TX, June 1, 1999.

**Pioneer Productions filmed the missile launcher and interviewed Russell Carter for a special about tornadoes to be shown on the Learning Channel, June 2, 1999, expected to air in January 2000.**

KRMG Radio, ABC affiliate in Tulsa, OK, interviewed Dr. Kiesling regarding the in-residence shelter, June 3, 1999.

Clear Channel radio stations (6 stations that all air 30 minute public service programs on Sunday morning), Tulsa, OK, interviewed Dr. Kiesling regarding the in-residence shelter, June 6, 1999.

Tulsa radio interviewed Dr. Kiesling on the telephone regarding the in-residence shelter, June 2-4, 1999.

KOTV, Tulsa, OK, interviewed Dr. Kiesling regarding the in-residence shelter, June 2-4, 1999.

KCBD-TV, Lubbock, TX interviewed L Tanner about the in-residence shelter, June 14, 1999.

**CBS Evening News interviewed L Tanner and showed footage of the missile launcher, June 25, 1999.**

KVII-TV, Amarillo, TX, featured an interview with R Carter during a 30-min morning program; Mr. Carter spoke about in-residence shelter and damage investigation research, July 12, 1999.

**ABC Radio Network interviewed J Schroeder at Kingsville, TX while deploying WEMITE in Hurricane Bret, August 22, 1999.**

KAMC-TV, Lubbock, TX, showed footage of WERFL in conjunction with coverage of Hurricane Bret, August 22, 1999.

Green Umbrella Productions interviewed A Gardner in Oklahoma City in regards to damage investigations during the May 3, 1999 tornadoes for a documentary, August 21, 1999.

ABC World News Tonight interviewed J Schroeder regarding WEMITE and needed research for boundary layer winds, Dr. D Smith regarding work at WERFL and wind-resistant construction and Dr. Kiesling regarding the in-residence shelter. They filmed the WEMITE team preparing to leave for Hurricane Dennis and the missile launcher at the Reese site, August 26, 1999.

KAMC-TV news aired an interview with J Schroeder about WEMITE research and deployment practice for the tower, August 26, 1999.

KAMC-TV news aired phone interviews with R Howard and S Balcar on the WEMITE team in North Carolina, August 27, 28 and 29, 1999.

On-line


The Weather Channel's web site mentioned Texas Tech's in-residence shelter as part of a series on protection in severe weather


FEMA's web site: http://www.fema.gov/mit/saferoom/ has information on safe rooms and National Performance Criteria for Tornado Shelters developed in conjunction with WERC.

"One year after Spencer tornado officials praise recovery, look toward building a safer future,”

Other
Wind Engineering donated some items representative of the work completed over the last 30 years for a time capsule to be buried by the Museum of Texas Tech for the millenium.

PROFESSIONAL ACTIVITIES

Classes/Presentations for Professionals


Training sessions for emergency managers on assessing performance of essential facilities in hurricanes, presented by D.A. Smith on 24-25 August 1998, Moultrie, GA; 27-28 August 1998, Warner Robbins,


K. Mehta moderated, J. McDonald participated as a panelist in a panel discussion on "Wind speeds in tornadoes: What we know and what we don’t know," as part of the Severe Weather Conference, sponsored by NWS and Wind Engineering, TTU, Lubbock, TX, February 9-11, 1999.

Texas Tech Engineering for Extreme Winds short course, Lubbock, TX, 3-5 February 1999 presented by K Mehta, J Minor, J McDonald and D Smith, and P Sarkar, 24 professionals.

Presentation on in-residence shelters for Amarillo Department of Emergency Management/National Weather Service Severe Weather workshop, Amarillo, TX, 10 April, 1999.


Seminar given by P. Sarkar for Dept. of Architecture students, Nagoya University, Japan, 19 May, 1999, 40 professionals.


Short course on "Engineering for Gulf Coast Hurricanes, Galveston, TX, presented by K.C. Mehta, J.E. Minor and Texas Department of Insurance personnel, 26-27 May, 1999.

Advisory Board meeting for improved standard/code for low building frames, includes Dr. Jim Delahay, Dr. Peter Irwin, Dr. Paul Senseny, Dr. Emil Simiu, Dr. Ted Stathopoulos, and Dr. Tim Whalen, Texas Tech Univ., Lubbock, 21 May, 1999.

Workshop on "Cable-Stay Vibrations," panel discussion led by P. Sarkar, 10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June, 1999.


Wind Engineering summer seminars includes the following presentations:
- Dr. Tom Gill: Dust in the Wind - Modeling and Monitoring Long-Distance Dust Transport to and from Lubbock, Texas
- Dr. Ernst Kiesling: Progress in Shelter Research
- Dr. Robert McComb: If Corpus was Miami: Hurricane Andrew Strikes Again
- Dr. H. Scott Norville: Glass Related Injuries from the Oklahoma City Bombing
- Ozlem Ozdemir: Beliefs and Behavior Towards Risk Mitigation
- Dr. Victor Shubov: Equations of Dusty Flow and Stability of Tornado Vortex

Atmospheric Science students present seminars during spring and fall semesters.

Workshop on "Cable-Stay Vibrations," panel discussion led by P. Sarkar, Atlanta, GA, organized by FHWA, TxDOT, AIDOT and GDOT, 30 August - 1 September 1999.

Awards/recognition
Dr. Mehta was named Outstanding Researcher in the College of Engineering, 1999.
Dr. Norville received the El Paso Energy Foundation Faculty Achievement Award, 1999.
Dr. Bilello received the New Faculty Award from the Texas Tech Ex-Students Association, 1999.
Dr. Sarkar, Dr. Zhao and T. Gardner received the John B. Hawley Award at the ASCE Texas Section meeting for the best technical paper at the section meeting for, "Aerodynamic Solutions to Cable Vibrations".
Dr. Bilello received 1999 Phi Kappa Phi. Honor Society award for outstanding academic and scholarly achievement. Texas Tech University, April 1999.

Meeting Participations
Bilello, J.
Association of Collegiate Schools of Architecture Board of Directors meetings December 1998 and March 1999
Association of Collegiate Schools of Architecture annual meeting, Minneapolis, March 1999
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

Chang, C.-B.
Conference on Hurricanes and Tropical Meteorology, Dallas, TX, 10-15 January 1999
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

Kiesling, E.W.
Participation at unveiling of FEMA storm shelter project, Tulsa Project Impact, Tulsa, OK, 7 December, 1998.
Parade of Homes, participated in news conference, interacted with FEMA and FL Dept of Community Affairs personnel, Ft. Myers, FL, 17-18 March 1999
Project Impact meetings with FEMA and city officials, Tulsa, OK, 11 May, 2, 6-7 & 10 June 1999.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.
Natural Hazards Conference, Boulder, CO, member of panel discussing Oklahoma tornadoes, 12-14 July 1999.

Kruse, J.B.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.
Seminar at Wharton University, Philadelphia, PA, 9 November 1998.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

McComb, R.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.

McDonald, J.R.
Workshop on Retrofit Research Needs organized and sponsored by TTU in collaboration with NIST, Atlanta, GA, 8-9 March 1999.
ASCE Wind Load subcommittee, Orlando, FL, 17-18 April; Chicago, IL, 20-21 November 1999.
ASCE Texas Section Engineering Education committee meeting and plenary session on Civil Eng education in Texas, Dallas, TX, 15-16 April 1999.
Institute for Building and Home Safety Wind Committee meeting, Raleigh, NC, 3 May 1999.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

Mehta, K.C.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting
with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.
Technology Assessment and Advisory Council of the NSF sponsored Colorado State University/Texas
Tech University Cooperative Program in Wind Engineering, Texas Tech University, September-
October 1998.
TxDOT Cable Stay Vibration progress meeting, 8 January 1999.
American Meteorological Society annual meeting, Dallas, TX, moderated panel discussion on wind
speeds in hurricanes, 12 January 1999.
ASCE Structures Congress, Orlando, FL, April 1999.
Texas Department of Insurance, seminar, 4-5 May 1999.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

Norville, H. Scott
ASTM E.06.51.13, E.06.51.17, E.06.51.18 and F.12.15 task groups formulating standards for glass-
related materials, Seattle, WA, 17-23 April 1999.
Glass Processing Days, Tampere, Finland, 11-16 June 1999

Peterson, R.E.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting
with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.
Invitational symposium, moderated session, Washington, D.C., 15 October 1998
Conference on Hurricanes and Tropical Meteorology and Symposium on Boundary Layers and
Turbulence, Dallas, TX, 10-15 January, 1999
National Severe Storms Laboratory organizational meeting for development of mobile doppler weather
radar, Norman, OK, 2 March, 1999.
Idaho National Environmental and Engineering Laboratories meeting, presented results of research by
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.

Sarkar, P.P.
Am Society of Civil Engineers-TX section state convention, Dallas, TX, 10-11 September 1998.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting
with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.
Second US-Japan Workshop on Wind Engineering, UJNR Task Committee ‘E’, Tsukuba, Japan, 24-27
May 1999.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.
Cable Stay Bridge progress meeting, Austin, TX, 8 January 1999.
Smith, D.A.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering meeting with Technology Assessment and Advisory Council, Lubbock, TX, 25-26 September 1998.
10th International Conference on Wind Engineering, Copenhagen, Denmark, 21-24 June 1999.
VISITING SCHOLARS AND DIGNITARIES

Steve Jones, Southwestern Public Service, visited WERC to discuss potential research in the arena of wind energy, 4 September 1998.

Dr. Arnold Court, climatologist, visited WERC to present a seminar on wind speed measurement, 12 October 1998.

Shanna Brown, Congressman Combest’s office, took a tour of the wind engineering facilities, 27 October 1998.


Clinton Williams, State Congressman Mac Thornberry’s office, toured the wind engineering facilities, 2 November 1998.

Dr. Jon Wieringa, Wageningen Agricultural University, The Netherlands, presented a seminar on “How Far Can Agrometeorological Station Observations be Considered Representative,” and visited with WERC staff on the planned meteorological tower. Dr. Wieringa oversaw the design and construction of a 213m tower at Cabauw, 6 November 1998.

Randy Poston, WDM and Mike Lynch, Tom Rummel and Elton Brown, TxDOT visited to discuss current TxDOT project on stay cable vibration, 22 February 1999.

Stuart Thurston, Engineer with Branz Engineering of New Zealand visited WERC facilities and discussed instrumenting full-scale buildings to measure wind pressure, 7-9 July 1999.

Dr. Chris Letchford (Dphil, Oxford University, 1987), a Reader in the Department of Civil Engineering at University of Queensland, Australia, has joined WERC as a Research Professor for a 2-year appointment. Dr. Letchford’s research focuses on the fields of fluid mechanics and structures. While at Texas Tech, Dr. Letchford will be involved in both full-scale and wind tunnel testing.
RESEARCH PROJECTS

Following is a summary of projects which were active during all or part of academic year 1998-1999. Project summaries are given for completed projects, progress summaries for those projects which are in-progress and plans for future research are given for those projects that have just begun. More information can be obtained from the project directors. See the wind engineering web site (http://www.wind.ttu.edu) for links to additional information available on-line.

Title: Cable Stay Bridge Vibration  
Sponsor: Texas Department of Transportation  
Amount: $145,277  
Duration: 9/1/97-8/31/99  
Director: Kishor C. Mehta  
Others: Partha P. Sarkar, Scott Phelan

The overall objectives of the project are to identify the cause of large amplitude cable vibrations on the Fred Hartman and the Veterans Memorial Bridges in Houston, TX and to develop strategies to control these vibrations. Personnel from the Johns Hopkins University, collaborators on the project, instrumented the Hartman bridge in the field to obtain vibration data and associated meteorological data during vibration periods. After preliminary analysis and interpretation of the data, they proposed mechanical strategies, i.e., dampers, to mitigate the vibrations. Concurrently, Texas Tech tested cable sections in the wind tunnel to measure the effectiveness of various aerodynamic mitigation devices: helical strake, elliptical ring and circular ring. The Veterans Memorial bridge has been instrumented to collect baseline data. ‘Circular rings’ will be installed on four cables to determine their effectiveness as an aerodynamic damper. Solutions developed in the course of this project may have significant implications for other cable stay bridges in existence and for the design of new cable stay bridges in the future.

Title: Central and South West System Renewables Project  
Sponsor: Central and South West Services, Inc.  
Amount: $685,305  
Duration: 8/1/93-1/15/00  
Directors: Edgar A. O’Hair and Phil Nash

The Central and South West System (CSW) Renewables project is aimed at assessing the potential of solar energy and wind power as alternative energy resources through a multi-faceted research program. The wind energy portion of the project is focused on the 12 turbine, six megawatt wind farm southwest of Ft. Davis, TX. This wind farm began producing electricity in 1996. Since that time Texas Tech has monitored the performance of the turbines as recorded by three companies: West Texas Utilities, the host utility; ZOND, the maker and installer; and Metro, Inc., an independent meteorological company that measures and records the wind speeds and directions in addition to ZOND’s. Early analysis was directed toward resolution of the difference in comparable data as recorded by the three organizations. The turbines have been accepted by CSW and the present on-site activities are associated with long term operation and maintenance/repair evaluations.

The present research activities are focused on the forecasting of wind at a specific site by use of
statistical methods and neural networks. The deregulation of electric utilities in the U.S. has
significantly increased the interest in being able to project the elective output from wind farms by as
much as 72 hours in advance. The Ft. Davis site is sufficiently remote that the Weather Service
forecasting service does not cover this area. Currently, the concept is to use the Lubbock airport as a
hypothetical site with turbines that perform as those at the Ft. Davis location. The objective is to
evaluate the two mathematical approaches with the same data set and determine the relative advantages
and disadvantages. A researcher on sabbatical from Denmark spent several months over the past year
assimilating and analyzing data from the wind farm.

Title: Computer Catastrophe Insurance Loss Models
Sponsor: Foundation for Insurance Regulatory Studies in Texas
Amount: $44,379 (total with subcontract $131,716)
Duration: 4/1/1999-4/1/2000
Directors: D.A. Smith
Co-PI: K.C. Mehta
Collaborating Institutions: Texas Department of Insurance and Texas Weather Center, Houston

The Commissioner of Insurance is mandated by the Texas Legislature to review residential and
commercial property insurance rates to assure that they are neither excessive nor inadequate. Property
insurance rates, however, should reflect, a provision for natural catastrophe losses, such as those caused
by hurricanes, if it is recognized that natural catastrophes increase the risk of insuring Texas consumers.
Computer models are a relatively new method to make provision for catastrophe losses in property rates.
They are being proposed as an alternative to the existing method of making provision for catastrophe
losses. This project will review and analyze current insurance ratemaking computer models and train
TDI staff to examine and respond to models offered in rate filings. Texas Tech will contribute to a report
describing the characteristics of computer catastrophe insurance models and develop a protocol that can be
used to review computer models used in rate filing.

Title: CSU/TTU Cooperative Wind Engineering Program
Sponsor: National Science Foundation
Amount: $350,000 for 1998-1999
Duration: 1/15/1995 - 1/14/2000
Director: Kishor C. Mehta
Others: Richard E. Peterson, Partha P. Sarkar, Douglas A. Smith, Jamie B. Kruse

The Cooperative Program in Wind Engineering with Colorado State University is in the fifth year of the
second five year program (1995-2000). The program contains four interactive tasks related to wind
effects on buildings: wind loads, wind flow around buildings, wind engineering meteorology and wind
damage economics. Characterization of pressures and overall loads on the building are additional aspects
of the wind loads task. Documentation of overall loads on WERFL has been temporarily interrupted by
installation of new pressure taps; additional taps are being added in the corner vortex region to better
characterize pressure differences seen between full- and model-scale. The relationship between wind
speed effects on minimum Cp for a range of wind speeds is being characterized. Another project is
measuring the overall wind loads on the test structure and developing a mathematical model to
characterize these overall loads in terms of the impinging flow characteristics of the wind. The
measurements were made using four load cells, one load cell placed at each corner of the building. Flow
visualization and characterization of roof pressures under the separation bubble and conical vortices continues. A roof corner vortex spoiler was tested and found to be effective in disrupting the formation of conical vortices by drawing air into the vacuum which forms under the vortices. The air flow direction is diametrically opposite from that within the vortex.

In the Meteorology task group, the Wieringa formula was applied to data from WERFL to create a chart of roughness lengths for all sectors of wind direction for the field site. Results indicated that both the gust factors and the roughness lengths obtained were higher than those from previous studies. As both meteorologists and engineers are interested in vertical wind profiles in high winds, data were obtained from four reliable hurricane wind records. Calculated roughness lengths were plotted and compared against the known topography of the site. The results showed a large variability according to the upstream fetch of the wind in the record. Another conclusion was that the gustiness of the wind during a hurricane is highly dependent upon the terrain and it is difficult to ascertain how turbulence caused by convection affects the gust factor and thus the roughness length. Work in the Economics task area has examined the market response to existing mitigation. Retrofit mitigation, in this case the presence of storm shutters, was found to be a significant variable to the selling price of homes in a coastal community. Progress on the project was presented and discussed with the Technology Assessment and Advisory Council in October 1998. Plans are underway for a symposium to be held in Fort Collins including all CPWE participants from the last ten years.

<table>
<thead>
<tr>
<th>Title:</th>
<th>Design of Residential Shelters from Severe Winds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sponsor:</td>
<td>Greenhorne &amp; O’Mara</td>
</tr>
<tr>
<td>Amount:</td>
<td>$138,935</td>
</tr>
<tr>
<td>Duration:</td>
<td>6/1/97-10/1/98</td>
</tr>
<tr>
<td>Director:</td>
<td>Ernst W. Kiesling</td>
</tr>
<tr>
<td>Other:</td>
<td>Kishor C. Mehta, Larry J. Tanner</td>
</tr>
</tbody>
</table>

In 1996, Wind Engineering Research Center (WERC) personnel completed a study refining criteria for design of shelters from extreme winds for the United States and its territories. Four geographic zones were outlined for which the threat from hurricane or tornado winds was defined. Both intensity and frequency of severe winds were considered in defining the threat. Design criteria for reliable, economical residential shelters were then defined for each zone.

In 1997 the Federal Emergency Management Agency (FEMA) awarded a contract to G&O to produce a booklet to present designs and specifications for residential shelters. Texas Tech University was awarded a sub-contract to test various building component concepts and to develop shelter designs for each zone defined in the earlier study. The booklet presents design variations for three types of shelter: reinforced concrete block, poured in place concrete and stud wall infill. Door options were expanded to include prefabricated steel doors as well as the site-built design. These designs accommodate the needs of new construction as well as retrofit of existing homes. The booklet published by FEMA, "Taking Shelter from the Storm: Building a Safe Room Inside Your House," is available free to the public.
Detection of Localized Structures in Hurricane Windfields

Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program
Amount: $58,754
Duration: 1/1/98-12/31/99
Director: Richard E. Peterson

Within hurricane damage swaths it often appears that bands of more extreme damage occur. It has been speculated that in the vicinity of the hurricane eyewall (a region of very high winds) tornado-like vortices may develop and yield the damage extremes. The objective of this study is to examine Doppler radar data for landfalling hurricanes in search of tornado-generating features. Software for a radar analysis program was acquired from researchers at NCAR who previously reported on small-scale bands within hurricane windfields. Work has begun to verify this analysis. Data were acquired for Opal, Fran and later hurricanes using the software.

Detection of Tornadoes Using Neural Networks

Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program
Amount: $141,018
Duration: 1/1/98-12/31/99
Director: Donald Wunsch

NEXRAD pulse Doppler radar systems, developed by the National Weather Service provide nearly complete national coverage for immediate forecasts, as well as archiving immense amounts of data for future research. Unfortunately, the spatial resolution of the NEXRAD system is insufficient to resolve a highly localized event such as a tornado. Instead, NEXRAD signal processing relies on detection of much larger-scale circulations, such as mesovortices, as an indicator and precursor of tornadoes. Unfortunately, this system provides a high probability of false alarm, which lowers public confidence and has caused many to ignore the warnings. This project will examine tornado detection as a classical decision theory problem and apply neural network techniques to develop an improved detector. NWS records (including post-storm assessment of the presence or absence of a tornado) and archived NEXRAD data (collected only in the last several years) provide a wealth of data for neural network training. To provide the public with advanced warning, we will study special neural network architectures specifically for this time-evolving pattern recognition problem. Receiver operator characteristics will be calculated and compared for current NWS techniques and our new neural network detectors.

Full-scale Tests of Vibration Mitigation Devices on Traffic Signal Structures

Sponsor: University of Minnesota
Amount: $68,752
Duration: 7/1/99-2/28/00
Director: James R. McDonald and Partha Sarkar

Various mechanical damping devices will be tested on the full-scale cantilever signal light structure at WERFL to assess their effectiveness to reduce large amplitude ‘galloping’ vibrations that tend to occur between 10-30 mph wind. Accelerations and displacements of the structure along with wind speeds will be monitored using strain gages. This investigation should refine and determine methods for mitigating fatigue-inducing effects of large amplitude vibration and other wind-related oscillations.
Title: Hurricane Georges Damage Documentation
Sponsor: Greenhorne & O’Mara, Inc.
Amount: $10,450
Duration: 7/1/99-2/28/00
Directors: James R. McDonald and Kishor C. Mehta

Ph.D. candidate, Carlos Compañy, participated as a member of FEMA’s Building Assessment Performance Team (BPAT) which was sent to Puerto Rico to investigate damage which resulted from Hurricane Georges. Mr. Compañy contributed to the wind portion of the BPAT report, “Hurricane Georges in Puerto Rico: Observations, Recommendations and Technical Guidance,” FEMA, March 1999.

Title: Mathematical Analysis of Tornado Dynamics
Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program
Amount: $66,702
Duration: 1/1/98-12/31/99
Directors: Victor I. Shubov and David S. Gilliam

There is an extensive meteorological and atmospheric science literature devoted to the study of tornado genesis and numerical studies of tornado dynamics. The resulting mathematical models are extremely beneficial in studying and predicting tornado behavior. Nevertheless, there remain many unanswered questions concerning tornado formation and dynamics and considerable controversy surrounding the proper mathematical formulation of the models. Furthermore, in the region of a tornado core, where sharp gradients of the velocity and pressure field occur, the numerical resolution of known computational schemes is inadequate. One of the most serious difficulties is the absence of rigorous mathematical results on existence of solutions and convergence of the associated numerical schemes.

Shubov and Gilliam are currently investigating a rigorous mathematical justification of a phenomenon, which has been established experimentally and justified only on a qualitative level by atmospheric scientists. The phenomenon consists in the following: adding an extremely fine dust to a laminar airflow results in reduction of the effective viscosity and has a destabilizing effect on the flow. In our work we consider a system of differential equations which govern airflow containing dust particles. This system includes the Navier-Stokes equations describing airflow and the Euler equations, which describe the motion of the dust. These two systems of equations are coupled through the so-called Stokes’ drag law. The entire system contains three important parameters: 1) the kinematic viscosity of the airflow, 2) the number of dust particles in a unit volume, 3) the mass of a single particle. The behavior of solutions under "the fine dust limit" is being studied. Namely it is assumed that the number of particles per unit volume goes to infinity and the mass of the particles goes to zeros in such a way that the product of these two parameters remains a constant. This implies that the dust concentration in the air remains a constant. Thus far it has been demonstrated that in this limit the solution of the original system converges to the solution of the single Navier-Stokes equation corresponding to a constant viscosity parameter whose value is somewhat lower than the original viscosity. As a result this process has the effect of lowering the effective viscosity of the flow. Future studies include a numerical study of the dusty flow equations.
Title: Numerical Model Study of Hurricane Boundary Layer Winds
Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program
Amount: $69,488
Duration: 1/1/98-12/31/99
Directors: Chia-Bo Chang and Arthur L. Doggett IV

During this project, two numerical weather models are being used to simulate landfalling hurricane boundary layer (BL) conditions to quantitatively investigate the observable and some of the non-observable details and mechanisms important in depicting the surface winds and convection distribution as well as their relationships to the damage field. The research goal is to determine to what extent the existing weather modeling techniques and observations are capable of providing guidance with real-time applications for effective damage assessment and disaster mitigation during a landfalling hurricane event. The two models are a dry hydrostatic model and a non-hydrostatic mesoscale model known as MM5. It is hypothesized that in the first few hours of landfall the BL processes and terrain would have the controlling role in defining hurricane wind damage. Thus the dry mesoscale model with an advanced treatment of BL physics and terrain forcings would perform equally well as the full-physics MM5 model during the short time period. It is anticipated that for the period of interest the dry model would catch the essentials of the hurricane BL winds even without reproducing the fine structure of the entire system. The hypothesis will be examined based on comparison between the dry and MM5 model simulations.

Several dry model simulation experiments have been conducted (Chang and Kasheta, 1999). These include a) experiments without terrain and friction and b) experiments with various shapes of artificial terrain. Recently, the effects of friction are added to the model. Also, the complex terrain of Taiwan is used in the dry model simulations. Results are quite interesting, but there are some unexpected features. Detailed model diagnostics are underway for a better understanding the impact of terrain on hurricane BL winds. In the first MM5 simulation of Hurricane Opal over the Gulf of Mexico (Howard and Chang, 1999), the model projected landfall about 4 hours before actual landfall and slightly to the west but otherwise very close to the actual track. The simulated pressure was much higher than the observed pressure. Wind speeds were typically about 15-20 m/s on average less than observed. Several additional simulations using MM5 yielded only limited success. The problems appear to be caused by the rather weak model initial state over the water. Work is continuing to refine use of MM5, but focused on landfalling typhoons in Taiwan. The complex terrain of Taiwan is ideal for this study.

Title: Performance Evaluation of Essential Facilities in Severe Windstorms
Sponsor: Georgia Emergency Management Agency
Amount: $298,750
Duration: 6/1/96 - 6/30/00
Directors: Douglas A. Smith and James R. McDonald
Res Assoc: Zhongshan Zhao

Even for relatively simple buildings with common construction materials, a detailed analysis of possible failure modes induced by wind loads would normally require an experienced structural engineer familiar with wind engineering. This project has developed a PC-based expert system that establishes the relative vulnerability of an essential facility to hurricanes or tornadoes. The procedure assesses wind resistance based principally on structural mechanics which can then be enhanced, where necessary, by expert judgement. The product produces a damage scenario and a vulnerability rating as a function of wind speed. The damage scenario establishes threshold wind speeds at which the building components and
The structural system will sustain damage. The software will provide emergency management officials with a tool to establish mitigation and retrofit options and priorities for essential facilities. The expert system is being designed for use by emergency management officials, architects, engineers and other construction technologists.

The expert system is complete though work continues on redesign of the user interface to require less specific engineering expertise from the data collectors. A user's manual has been developed and revised. Calibration of the expert system and development of the damage scenario remains to be accomplished. Several training sessions have been presented and were well received.

Title: Technology Application and Transfer Program (TATP)
Sponsor: Texas Economic Development Board
Amount: $2,000,000
Duration: 7/1/99-one year from completion of system
Directors: Tim Doggett

Texas Tech is currently deploying a network of meteorological instrumentation (MesoNet), across the western part of Texas designed to collect data on a spatial resolution of 40 km, and with a time interval of 15 minutes. This represents a vast improvement over the currently available data collected at a spatial scale of approximately 100 miles and time interval of one hour. Such a data set will be of great value in a wide range of applications including agriculture, power utility planning, education, weather forecasting, and air quality assessment.

The MesoNet program will integrate meteorological data collected from three different data collection platforms. The first will be information about surface weather conditions, each surface site consisting of a 10 m tower that will provide wind and temperature data, humidity, pressure, rainfall, and solar radiation measurements near ground level; and data on soil temperature and moisture. The second data set, collected from atmospheric profilers, will be information about wind and stability conditions from a deeper layer of the atmosphere. These instruments use Doppler technology to measure wind and temperature from about 100 m above the surface to altitudes of approximately 5 km above the surface. The last data set will be wind and weather information collected from tall towers to provide data at heights from 10 m above the ground up to 200 m. The processed data sets will eventually be passed along to the end-users via the Internet or dial-up computer systems. In cooperation with Texas A&M University, it is hoped to extend this network across the state.

Title: Technology Service in Windstorm Mitigation
Sponsor: Federal Emergency Management Agency
Amount: $100,000
Duration: 6/22/99-6/21/00
Directors: Kishor C. Mehta
Res Assoc: Larry J. Tanner, April MacDowell

The objective of the Information/Outreach Center is to make research results available to professionals and the general public through the use of multi-media and conferences and to impart windstorm information to school children. IOC will make on-line information available to practicing engineers and architects, contractors and the public regarding wind-resistant and occupant-protective construction. A
website (http://www.wind.ttu.edu) was established as a resource to the public and professional community. Since the completion of the FEMA booklet on design for occupant-protective construction in hurricane- and tornado-prone areas, a large number of specific technical questions have been received by e-mail and through a toll-free number (e.g. 800-TTU-WIND). A professional staff person is in charge of responding to or referring inquiries, consulting with senior faculty as needed.

**Title:** Texas Tech Connectivity to the vBNS  
**Sponsor:** National Science Foundation  
**Amount:** $350,000  
**Duration:** 8/1/99-7/31/01  
**Director:** Lawrence Schovanec (administered by Computing and Information Resources)  
**Co-PIs:** Douglas A. Smith, Arthur L. Doggett and others

This grant provides partial support of a DS-3 connection to the gigaPoP at Texas A&M University's (TAMU) Houston Institute of Biosciences and Technology (IBT). Applications will include IP multicasting, both point-to-point and multicast, retrieval of real-time and archived data sets used in developing innovative multimedia applications for accessing and analyzing meteorological data and precision agriculture. Support of system-level experiments on the active and passive components for Dense Wavelength Division Multiplexing (WDM) is another intended use of the vBNS. This system will allow WERC to permit access of real-time data from WERFL.

**Title:** Tornado Missile Studies-Completion  
**Sponsor:** Lawrence Livermore National Laboratory  
**Amount:** $8851  
**Duration:** 4/26/99-8/31/99  
**Directors:** James R. McDonald

High winds tend to pick up and transport objects and debris which become missiles causing damage by perforating the building envelope or collapsing structural elements such as walls, columns or frames. Information synthesized from Texas Tech's windstorm damage documentation experience of over 25 years and computer simulations provide the basis for wind-borne or tornado missile criteria for the design and evaluation of DOE facilities. Missile impact tests conducted at Texas Tech augmented by missile impact studies in the literature were used to develop guidelines for the design and evaluation of impact-resistant missile barriers for DOE facilities. Recommended wall sections include walls constructed of reinforced concrete, clay brick and concrete masonry.

**Title:** Wind and Building Pressure Field Data and its Simulation in the Laboratory  
**Sponsor:** Idaho National Engineering and Environmental Laboratory (INEEL)  
**Amount:** $75,376  
**Duration:** 3/30/98-11/30/99  
**Director:** Kishor C. Mehta  
**Others:** Richard E. Peterson and Douglas A. Smith  
**Res Assoc:** John Schroeder
A collaborative effort between three institutions; Texas Tech University (TTU), Clemson University (CU) and the University of Notre Dame (ND), has conducted research in hurricane winds and building pressure data in the field and to develop a control algorithm to simulate hurricane winds. The three-year effort involves four interrelated tasks: (1) Develop a control algorithm to simulate wind turbulence and its validation through laboratory experiments (CU), (2) Conduct a global search for hurricane wind data and perform statistical analyses (in process), (3) Develop a portable tower system and pursue recording of high resolution wind data in land-falling hurricanes (see below), and (4) Measure wind and associated pressure data on a sloped roof in the field.

A 35ft mobile instrumented tower was designed, constructed and tested. The tower was deployed at Rockport, TX for Tropical Storm Charley, at Wilmington, NC for Hurricane Bonnie, at Panama City, FL for Hurricane Earl and at Gulfport/Biloxi, MS for Hurricane Georges. A new tower with modifications based on experience with WEMITE I was designed and built. For the 1999 season, before the end of August, WEMITE I and II had deployed for Hurricane Bret in Texas and Dennis in North Carolina. Good data on wind speeds, temperature, relative humidity and barometric pressure were obtained. In Bonnie, the tower was deployed near the NWS ASOS site and thus a comparison of the two wind records was possible. Roughness lengths upwind from the sites were calculated using a gust factor model developed by Wieringa. The calculated gust factors from the ASOS and WEMITE data (when the wind approached from an open exposure) fit well within the range of gust factors determined from other studies.

Title: Wind Engineering Research Center
Sponsor: State of Texas (Line Item Funding)
Amount: $261,000 annually
Duration: 9/1/93 - 8/31/00
Director: Kishor C. Mehta
Others: Faculty Investigators in Wind Engineering

The Wind Engineering line item is used to generate additional funds, provide a transition between projects, and fund small projects in various departments, some of which may later lead to additional funded projects. Some of the projects partially or completely supported encompass faculty and students from Civil and Mechanical Engineering, Computer Science, Architecture, Atmospheric Science, Economics and Mathematics. Some of the projects are statistical validation procedure for wind pressure data; roof corner pressures; fluctuating pressure loads on bluff bodies; roughness length description based on roughness element height and density; empirical study of hurricane mesovortices, polygonal eyewalls, and eyewall contraction and replacement cycles; and numerical simulation of turbulent wind flow and fluctuating roof pressure on low rise buildings using CFD.

The project provides support to Research Associates, Graduate students, Undergraduate students, WERC staff and a few faculty. In addition, publications and outreach activities are supported by this project. A web site has been developed which includes information on the graduate program in Wind Engineering, a brochure on the in-residence storm shelter, a listing of upcoming international conferences and local seminars, the Wind Engineering publications list and the Wind library catalog.
Title: Windstorm Mitigation Initiative
Sponsor: National Institute of Standards and Technology (NIST)
Amount: $3,601,942
Duration: 8/1/98-7/31/99
Director: Kishor C. Mehta
PIs: Ernst W. Kiesling, H. Scott Norville, Douglas A. Smith, James R. McDonald, Jamie Kruse, Richard E. Peterson
Faculty: Joseph Bilello, Arthur L. Doggett IV, James Dunyak, Marc Giaccardo, James Gregory, Glenn Hill, Robert McComb, Harry Parker, Partha Sarkar
Res Assoc: Russell Carter, Tom Gill, Kathleen Gilliam, Larry Tanner

The objective of the project is to conduct research on mitigation of detrimental effects of windstorms on low buildings and structures and on wind damage economics and to facilitate technology transfer. The goal is to achieve life safety, to minimize community life disruption and to mitigate property damage consistent with the economics of construction.

A team of sixteen faculty members from the disciplines of civil and chemical engineering, architecture, atmospheric science, mathematics and economics has been assembled to pursue research and technology transfer activities. The team has developed seven interrelated research thrust (RT) areas to achieve progress toward the objective of the project. RT1, Occupant protection from severe winds, is focusing on development of design criteria for in-residence shelters, assisting manufacturers in design and development of shelters, and assessing the economic impact of shelters. RT2, Debris impact research, has developed new missile launchers which allow a wider range of movement, and is conducting research to establish missile impact probabilities, and investigate the windborne missile field. RT3, Windstorm damage documentation, has developed goals, procedures and a database documentation system for damage investigation. Three teams were sent to Oklahoma City to investigate damage from the May 3 tornadoes.

Research for RT4, Integrated testing for wind effects, relative to WERFL includes refinement of data processing, establishing internet access to this database, characterization of roof and wall corner pressures, assessment of overall loads, and installation of new taps to allow additional experiments. A new structural platform and 200 m tower will be installed. Calibration of the boundary layer wind tunnel is awaiting delivery of instrumentation. RT5, Retrofit of existing buildings, convened a Retrofit workshop with individuals representing various institutions and agencies to prioritize a list of retrofit research needs. Interim Guidelines for Retrofit of Existing Residences is currently being prepared. RT6, Wind damage economics, is developing a GIS-based characterization for Corpus Christi incorporating building data with wind and storm surge models. A survey on willingness to pay for in-residence shelters has been completed and is being analyzed. Research continues on evaluation of economic factors on mitigation in general. RT7, Wind erosion, has determined appropriate instrumentation to be included on the 200m tower. A user-friendly program for a wind-erosion model has been developed. In addition, an Information and Outreach Center (IOC) maintains the Wind Engineering web site, and answers/refs inquiries from the public on a variety of wind-related topics.
PUBLICATIONS AND REPORTS FROM WERC PROJECTS

Refereed Journals, Proceedings and Books


Proceedings and Presentations


Reports


WIND ENGINEERING PERSONNEL
1998-1999

Wind Faculty

Joseph Bilello, Associate Dean for Research, College of Architecture
Chia-Bo Chang, Associate Professor, Atmospheric Science
Arthur L. Doggett IV, Assistant Professor, Atmospheric Science
James P. Dunyak, Assistant Professor, Mathematics and Statistics
Michael G. Giesselmann, Associate Professor, Electrical Engineering
David S. Gilliam, Professor, Mathematics and Statistics
James M. Gregory, Associate Dean for Undergraduate Studies, College of Engineering
Glenn E. Hill, Associate Professor, College of Architecture
Darryl James, Associate Professor, Mechanical Engineering
Ernst Kiesling, Professor, Civil Engineering
Jamie B. Kruse, Associate Professor, Economics
Jeff Lee, Associate Professor, Geography
Chris Letchford, Research Professor, Civil Engineering
Robert P. McComb, Associate Professor, Economics
James R. McDonald, Chairman and Professor, Civil Engineering
Kishor C. Mehta, P.W. Horn Professor, Civil Engineering
Kevin R. Mulligan, Assistant Professor, Geography
H. Scott Norville, Professor, Civil Engineering
Edgar A. O’Hair, Professor, Electrical Engineering
J. Walter Oler, Associate Professor, Mechanical Engineering
S. Parameswaran, Associate Professor, Mechanical Engineering
Harry W. Parker, Professor, Chemical Engineering
Richard E. Peterson, Chairman of Geosciences and Professor, Atmospheric Science
Scott Phelan, Assistant Professor, Civil Engineering
Partha P. Sarkar, Associate Professor, Civil Engineering
Victor Shubov, Associate Professor, Mathematics and Statistics
Douglas A. Smith, Assistant Professor, Civil Engineering
Milton Smith, Professor, Industrial Engineering
Donald Wunsch, Associate Professor, Electrical Engineering

Research Associates

Russell Carter
Tom Gill
Xiaoning Li (Kathleen) Gilliam
Bruce Haynie
Seoung-Hwan Jeong
Alfred Karstinsn
April MacDowell
Phil Nash
John Schroeder
Larry Tanner
Zhongshan Zhao

Staff

Chad Morris (Associate Director)
Steve Tyrer (Program Analyst)
Joyce Domansky (Clerk Spec)
Lynnetta Hibdon (Technical Writer)
Elizabeth Johnston Vasquez (Secretary)
George Garcia (Technician)
Jeff Livingston (Technician)
Graduate Students
Yahya Al-Menyawi (CE) PhD
Erik Allen (CE)
Mark Bertau (Atmo)
Mark Bird (CE)
Scott Bole (CE)
Rick Brandt (Atmo)
Bin Cai (CE) PhD
Mark Coates (Math)
Carlos Compañy (CE) PhD
Mark Conder (Atmo)
Ryan Donahue (CE)
Rebecca Fagan (CE) PhD
John Fernandez (ME)
Mona Fritsch (CE)
Anna Gardner (CE) PhD
Tom Gardner (ME)
Dan Grams (Atmo)
Rob Howard (Math) PhD
Urmilla Jokhu (CE)
Sridhar Kamban (CE)
Timothy Kasheta (Atmo)
Rohit Kaul (CE)
Tarek Kewaisy (CE) PhD
Chun Man Kwan (Math) PhD
Seth Nagle (Atmo)
Ozlem Ozdemir (Econ) PhD
Ali Pietrycha (Atmo)
Roberto Rodriguez-Mendieta (CE)
Anindya Sengupta (CE) PhD
Kevin Simmons (Econ) PhD
Gary Skwira (Atmo) PhD
Tufan Tiglioglu (Econ) PhD
Robert Tisdal (Arch)
Steve Weinbeck (Atmo)
Fuqiang Wu (CE) PhD
Nan Zhou (CE)
Runlin Zhu (CS)
Bryan Ziegler (Arch)

Undergraduates
Rachel Aivano (REU, Atmo)
Arthur Allen (Und)
Jason Allen (CE)
Rachel Artho (CE)
Jaime Bailey (ChemE)
Shannon Baker (CE)
Nadine Balcar (Educ)
Shawn Balcar (CE)
Sarah-Margaret Barnard (CE)
Jacob Bice (REU, EE)
Coy Bryant (CE)
Kevin Chappell (CE)
Tyson Cox (CE)
James B. Curry (CS)
Mark Domansky (EE/CS)
Rachel Dowlen (CE)
Jack Evans (CE)
Leticia Flores (Human Sci)
Mike Garcia (CE)
Chad Gardiner (CE)
Nebil Hamza (CE/Math)
Laci Hardin (CE)
Amber Harris (CE-Env)
Ann Marie Haynes (Bio/Pre-Med)
Jonathan Hoak (CS)
Shannon Hutchison (CE)
Andrew Ickert (CE)
Ryan Jackson (CE)
Kevin Johnson (CE)
Laura Karwatka (CE)
Tyler Mackay (CE)
Mark Martinez (CE)
Jay Miller (Econ, REU)
Cody Moody (CE)
Stephen Morse (CE)
James Oberholz (CS)
Chris Ordonez (Temp)
Lawrence Peck (CS)
David Quinn (CE)
Bryan Robertson (CE)
Victor Roden (CE)
Anthony Rodriguez (CE)
Erick Sagebiel (ENPH)
John Shockley (CE)
James Snelson (ME)
Ameri Stuckley (CE)
Anson Thompson (CE)
Steven Valenta (Arch)
Courtney Van Ingen (CE)
Brett Walker (CE)
Kevin Witt (Arch)
Janie Wood (CE)
Tom Wuensche (CE)

The aerodynamic roughness length is a parameter that quantifies the degree of friction that terrain elements have on the wind near the earth's surface. It is commonly used in the development of vertical profiles of the wind speed. However, uncertainty exists in the precision of current roughness length estimation schemes. A formula has been developed by Wieringa (1973) that calculates the roughness length from gust factors (ratio of the peak wind gust to the mean wind speed over a period). This method has an advantage in that it relies on readily available local wind data such as analog record charts found at the NWS.

This study employed the Wieringa formula to evaluate its applicability and ease of use with a number of different types of wind records. First of all, the formula was applied to data collected at the Texas Tech Wind Engineering Research Field Laboratory (WERFL), where wind speed records are archived from five different vertical levels. Results indicated that both the gust factors and the roughness lengths obtained were higher than those from previous studies. Secondly, because both meteorologists and engineers are interested in vertical wind profiles in high winds, an attempt was made to obtain wind records from several hurricane passages. Four reliable hurricane wind records from anemometers located in the vicinity were acquired: Hurricane Bob (1991), Hurricane Iniki (1992), and two from Hurricane Bonnie (1998). The Wieringa formula requires specifications of the anemometry and since each record was produced by a different anemometer/recorder system, they provided a thorough assessment of the formula. Calculated roughness lengths were plotted and compared against the known topography of the site. The results showed a large variability according to the upstream fetch of the wind in the record. Another conclusion was that the gustiness of the wind during a hurricane is highly dependent upon the terrain and it is difficult to ascertain how turbulence caused by convection affects the gust factor and thus the roughness length.


Rain and wind induced vibration in the stay-cables of stay-cable bridges is a problem that is generating greater attention as more of these bridges are constructed around the world. At issue is the possibility of fatigue of the stay-cable attachments at the bridge deck and tower as well as the material that makes up the stay-cable itself. The vibrations are most prevalent during moderate to heavy rain and light wind conditions below 30 mph, but also occur at high wind speeds with no rain.

The proposed cause of the vibration problem is the change in cross-sectional shape of the stay-cable that occurs when rain forms one or more beads, or rivulets, along the cable surface. This modified cross section affects the aerodynamics of the stay-cable and, as a result, large vibrations occur at wind speeds well above the known vortex shedding wind speeds for cylindrical bodies. Often, these large magnitude vibrations were not accounted for by the bridge designers and engineers and modification of existing cables becomes necessary.

This work presents the existing schools of thought on the mechanism that causes the extreme vibrations of stay-cables. In addition, a section model suspension and force measuring system is
developed to study the behavior of stay-cables in the wind tunnel. Data are presented from a stay-cable section model study using the above mentioned force measuring system. Further, suggestions are made for future study of the stay-cable vibration problem based on the results of this work and the work of other researchers.


Guyed masts are unique structurally efficient, self-supporting lattice towers. They are used extensively by the telecommunication industry but have a high rate of failure. This report develops a computer model for static and dynamic analysis of wind loads on guyed towers. For static analysis, mean wind velocities are calculated by log law; for dynamic analysis, 15 minute wind data from the Wind Engineering Research Field Laboratory was used. Cable analysis was based on a finite element model, which had the advantage over other models in its capability to evaluate lateral wind load effects. Analysis of the mast as a 3D truss provided several advantages particularly in requiring fewer initial assumptions. Static analysis of the cable-mast interaction yielded forces 4.5 times that of initial conditions under certain wind loads. Dynamic analysis showed that wind fluctuations at 25 m/s were a significant factor to tower response. Recommendations for future research are listed.


Evidence indicates that intermittent coherent structures in the windfield may be responsible for wind damage. Since standard statistical techniques assume that time series are stationary, identification of intermittent phenomena is challenging. The issue of estimating intermittency rate of localized phenomena using wavelets is addressed by using a rigorous statistical algorithm which allows for longer time series detection. Coherent structures were detected within the frequency corresponding to windspeed.


This thesis studies and analyzes one of the first tornado models derived from the Navier-Stokes equations for incompressible fluid called the Burgers-Rott model. A derivation of the model is presented presented autonomously from the original work. All cases of the model are considered including those which, due to physical restrictions, do not produce a tornado. A graphical representation was constructed using Matlab. The model was shown to be flawed in some of its assumptions, which advocates the need to study more sophisticated models that have been developed over the past forty years.


Additional construction in coastal areas has led to increased losses from windstorms in recent years. This project examines the economic value of mitigation to potential homeowners. A search of the risk and mitigation literature lays the foundation for the study. A theoretical model for determining benefit of insurance and mitigation against a low probability high consequence event is developed. Data from a Gulf Coast city is used to test the value of mitigation empirically. A single mitigation feature (storm shutters) is isolated and its significance tested using a standard econometric technique.
A structural integrity index based on engineering relationships is used to test whether the market places a higher value on more storm-worthy structures. For this feature, the increase in selling price of a home with the feature almost completely covered the installation cost. Results from a laboratory experiment provided additional information on human reaction to low probability high consequence events. The economic data collected for this thesis indicate that, confronted with the risk of natural disaster, individuals do respond positively towards mitigation measures.


Hurricanes have caused billions of dollars of damage and claimed many lives over the years. Hurricanes are major events, but since they happen relatively infrequently at any one location, meaningful statistics cannot be compiled at a single site from the historical records. Thus, an indirect method of obtaining useful hurricane wind statistics is needed. One such method investigated in this thesis is known as a Monte Carlo simulation.

A Monte Carlo simulation is a procedure whereby many idealized tropical storms and hurricanes are generated using a computer simulation. In this procedure, relevant meteorological parameters such as the radius of maximum winds, the central pressure, and the speed and direction of the hurricanes motion are randomly selected from probability density functions developed from historic data. The information selected is then used to initialize the wind field model. The hurricane is then propagated, and the maximum wind speed and wind direction at the site of interest is captured. This process of initialization of the hurricane wind field, propagation of the hurricane, and capturing of the maximum wind speed and direction at the site is performed repeatedly. Assuming the hurricane wind model and the hurricane parameter statistics are reasonable for the site in question, statistically significant wind statistics result. The resulting database of wind speeds and directions can be used by engineers to establish load factors for the design of structures.

This thesis takes a closer look at the Monte Carlo simulation method for a number of sites along the United States Gulf and Atlantic Coast. The resulting wind statistics are then presented and a number of interpretations, conclusions, and possible suggestions are discussed.
PROPOSALS SUBMITTED

*Characterizing Turbulence during Extreme Wind Events*, Texas Higher Education Coordinating Board, Advanced Research Program, R.E. Peterson and Xiaoning Gilliam, in collaboration with Stephen F. Austin State University, 1/1/00-12/31/01, $109,990 ($68,757) funded.


*Full-Scale Test of Vibration Mitigation Devices on Traffic Signal Structures*, J.R. McDonald and P.P. Sarkar, NCHRP, subcontract from University of Minnesota, 6/01/98-5/31/00, $17,187, funded.

*Fuzzy Damage Assessment and Risk Analysis along Tornado Destruction Paths*, Texas Higher Education Coordinating Board, Advanced Technology Program, J. Dunyak and J.R. McDonald, 1/1/00-12/31/01, $101,571, not funded.

*Geochemical Fractionation of Dust at the Surface of a Wind-Eroding Playa*, Texas Higher Education Coordinating Board, Advanced Research Program, T.E. Gill, 1/1/00-12/31/01, $55,125, funded.

*GIS Modeling of Wind Damage*, Texas Higher Education Coordinating Board, Advanced Technology Program, R.E. Peterson and T.E. Gill, 1/1/00-12/31/01, $179,050, not funded.

*Hurricane Tornadoes: Criteria for Detection*, Texas Higher Education Coordinating Board, Advanced Research Program, R.E. Peterson, 1/1/00-12/31/01, $60,070, not funded.


*Mobile Models*, Georgia Emergency Management Agency, D.A. Smith & E.W. Kiesling, 10/1/993/31/00, $25,000, pending.


*Proper Orthogonal Decomposition Modeling of Pressure Fields over Low-Rise Building*, Texas Higher Education Coordinating Board, Advanced Research Program, D. Smith and X. Gilliam, 1/1/00-12/31/01, $93,406, not funded.