University of Greenwich press release: Tuesday, September 9, 2008

Evidence of survivors of 9/11 will help save lives in future high rise evacuations

New research involving face-to-face interviews with survivors of the 9/11 attack on the World Trade Centre (WTC) will help save lives in the future.

Researchers from the Universities of Greenwich, Ulster and Liverpool have completed a three and a half year study into the evacuation of the twin towers. Interviews with 271 survivors generated 6,000 pages of first hand accounts of what it was like as they tried to leave the buildings.

Preliminary findings include:

- more than half the occupants stayed to carry out tasks before evacuating;
- occupants seeking information about what was happening took between 1.5 and 2.6 times longer to respond;
- congestion on the stairs was the main cause of delay, even though the towers were less than one-third occupied that day;
- computer simulations of the evacuation of the North Tower suggest that had the building been fully occupied at the time of the attack, some 7,592 people would have died in the North Tower alone;
- computer analysis suggests that for buildings above a critical population and height, stairs alone will not be sufficient to safely evacuate the entire building population.

The research has been welcomed by Sally Regenhard, Chairperson of the Skyscraper Safety Campaign and mother of a firefighter lost at the WTC. She says: “Designers of high rise buildings and their evacuation procedures are architects of destiny for millions around the world. When I see a new skyscraper, I want to know that the deadly mistakes of 9/11 have been corrected.”

Many of the survivors said they had benefited personally from taking part in the research. “Some of us believe that the only way to deal with the aftermath of the event is to talk about it and that any lessons learned from the events of the WTC evacuation on 9/11 should be shared so that we can be better prepared,” said one participant.

Thousands of details have been entered in a database known as HEED High-rise Evacuation Evaluation Database) and modelled by computer to reveal vital information which will improve the safety of high rise buildings around the world. The project has been funded with an £1.6 million grant from the UK Engineering & Physical Sciences Research Council (EPSRC).

Project Director Professor Ed Galea of the University of Greenwich says: “Together these personal stories paint a comprehensive picture of what

happened and why. What influenced evacuees' behaviour? What was going through their minds when they made key decisions? This is a hugely important body of data in itself. We will be making the HEED database available to bone fide researchers all over the world, so that it can become a valuable international resource for others to use."

The HEED database is already providing new insights which could lead to the development of safer evacuation procedures, contribute to improved building regulations around the world and lead to more sophisticated evacuation modelling tools. For example, analysis reveals that while people travelled more slowly down the WTC stairs than engineers predicted, based on earlier human behaviour studies, this was not due, as some leading evacuation specialists had suggested, to growing levels of obesity in the community, but primarily to the high levels of crowd density that existed on the stairs.

One survivor told researchers: "Other people were coming in…the stairwell from whatever floor they had come from [the travel speed]… slowed down dramatically. We stopped at [floor] 55, right there, because there was obviously a lot more people. I mean we were running down for the first five stairs, "Boom, boom, boom, boom, boom," two stairs at a time sometimes. When we got to 55, we couldn't do that because we would plough into people."

Overall 82% of those interviewed said that they stopped at least once; a small number stopped more than 20 times during their descent. Congestion was the primary cause of stopping (44% of incidents), followed by ascending fire fighters and descending groups of injured people (17.6%). Only a minority of evacuees needed to take a rest (causing 9.7% of stoppages), or were stopped by environmental conditions such as debris, smoke, heat and water on the stairs (3.5%).

Occupant response time is another important parameter defining the success or failure of an evacuation. Generally, the longer people take to start their evacuation the longer it will take for them to safely get out. The response time is also an important parameter in evacuation simulation used in design calculations. "Engineers tend to use arbitrary values for response times in design calculations, often using rather fast response times such as 1-2 minutes for high-rise building simulations," says Prof Galea. The HEED data suggests that over half the sample of people analysed had response times between one and eight minutes. "To try and reduce occupant response times we need to understand what factors contribute to prolonging people's response to emergency situations" says Prof Galea. The data suggests that more than half of the interviewees stopped to carry one or two tasks before starting their evacuation and those seeking information took between 1.5 and 2.6 times longer to respond than those who didn't. "Providing people with good information about what is happening and what to do can significantly reduce occupant response times, and lead to a safer evacuation," says Prof Galea. "These results quantify the benefits that can be derived from providing hardened emergency communications systems within buildings."

Computer simulations of the evacuation of the North Tower were also conducted as part of project HEED, revealing how much worse the situation would have been had the building been fully occupied. Using their buildingEXODUS

evacuation software, staff from the University of Greenwich demonstrated that had 25,000 people occupied each of the WTC towers rather than 8,000 in each, some 7,592 people would have died in the North Tower alone, compared with the 1,462 actual number of fatalities. Generalising the analysis suggests that for a given stair provision within a high-rise building, there is a critical floor population which effectively limits the height of building that can be evacuated by stairs alone. “This is an important observation because it suggests that for buildings above a critical population and height, stairs alone will not be sufficient to safely evacuate the entire building population”, says Prof Galea. “For such buildings, additional evacuation provision will need to be provided, for example through the use of specially designed lifts/elevators.”

The University of Greenwich is already exploring the use of lifts for evacuation of high-rise buildings using their buildingEXODUS evacuation model. They are currently developing enhanced human behaviour models that simulate the choices people make in deciding to use a lift/elevator or stairs as part of their evacuation route. You can help with this research by completing an on-line questionnaire at the University of Greenwich website:
http://fseg.gre.ac.uk/elevator

As a thank you to the survivors who took part in the project, the research team has donated US $5,420 to the participants’ chosen charity, the World Trade Centre Survivors' Network.

- *[For US media]:*The WTC Evacuation Study is a collaborative project involving the people of New York and New Jersey and the Universities of Greenwich, Liverpool and Ulster in the UK, which is being funded by the UK’s Engineering and Physical Sciences Research Council (EPSRC) with a grant of $2.9m. It is endorsed by the New York City Department of Buildings, The Fire Department of New York, and is supported by three of the city’s universities, John Jay College of Criminal Justice (New York City), Pace University and Poly University.

Prof Galea’s five rules that could mean the difference between life and death in an emergency evacuation:

Lesson 1: Don't do anything to delay your departure
Lesson 2: Know your way out
Lesson 3: Don't stop on the way to reassure friends and family
Lesson 4: Don't discard your shoes on the stairs
Lesson 5: Know how long it will take to get out

Photo caption: Professor Ed Galea with two HEED researchers

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NOTES FOR EDITORS

1. *The UK WTC9/11 Evacuation Study: An Overview of the Methodologies Employed and some Preliminary Analysis,* Galea, Hulse, Day, Siddiqui, Sharp, Shields, Boyce, Summerfield, Canter, Marselle and Greenall To be published in the Proceedings of the 4th Pedestrian and Evacuation Dynamics (PED) Conference, University of Wuppertal, Germany (2009)

2. *Approximating the Evacuation of the World Trade Center North Tower using Computer Simulation*, Galea, Sharp, Lawrence, Holden, Journal of Fire Protection Engineering, Vol 18 (2), 85-115, 2008.

3. The HEED project: further information is available from: www.wtc-evacuation.com

4. The lift/elevator on-line questionnaire is available from: http://fseg.gre.ac.uk/elevator.

5. Project HEED lead academics:

Professor Ed Galea
Professor Ed Galea is the founding director of the Fire Safety Engineering Group (FSEG) at the University of Greenwich and is the lead investigator in the HEED project. His work in fire safety engineering began after the tragic Manchester Boeing 737 fire, when he was commissioned by the UK Civil Aviation Authority to simulate the spread of fire and smoke in the disaster. His research interests include the modelling of evacuation, people movement, fire/smoke spread, combustion and fire suppression in the built environment, rail, marine and aviation environments. Professor Galea is the author of over 100 academic and professional publications related to fire. He serves on a number of national and international standards and safety committees concerned with fire and evacuation including BSI, ISO, IMO and SFPE.

The Fire Safety Engineering Group (FSEG) of the University of Greenwich
FSEG consists of a 30-strong multi-disciplinary team of mathematicians, research psychologists, fire safety engineers and computer scientists. The group was established in 1986 and has researched fire dynamics and human behaviour associated with fire for over 20 years. These efforts have lead to the development of the SMARTFIRE fire simulation software and the EXODUS suite of evacuation models which are in use in 30 countries around the world. The group has won a number of prestigious national and international awards for their research work including the Queen's Anniversary Prize 2003 and was one of the winners of the European IST Award 2004. http://fseg.gre.ac.uk

Professor Jim Shields
Prof. Jim Shields is Emeritus Professor of Fire Engineering in the Faculty of Engineering, University of Ulster. He was until January 2004, the founding Director of the Institute for Fire Safety Engineering Research and Technology (FireSERT) at the University of Ulster. Jim has over thirty years experience working in the field of fire safety engineering. He has over 120 journal and other publications and three books to his credit. He serves on many national and

international committees concerned with fire safety engineering including NIBRAC, BSI, ISO, CENN and CIB. His research interests include human behaviour in fire, people movement, evacuation simulation and fire dynamics.

FireSERT University of Ulster
FireSERT brings together a large multi-disciplinary team of scientists, engineers and psychologists working in the field of fire science and fire safety engineering. FireSERT in 2001 was the recipient of a Joint Infrastructure Award of £5.7m to build new state of the art fire safety engineering research facilities. The new laboratory facilities which are now fully operational include a human behaviour in fire research suite. Current research includes studies into the wakefulness of sleepers to fire stimuli and behaviour of people exposed to fire in their homes. Works of the human behaviour in fire research group have been published as BRE documents.

Professor David Canter
Professor Canter started studying human actions in fires and similar emergencies in the late 1970's. This work, supported by government departments, and charitable trusts laid the foundations for current thinking on designing for and managing human behaviour. This work was the basis for Professor Canter's advice to a number of government enquiries into major fires. It developed into studies of safety in industry which became the basis for a very successful behavioural approach to reducing accidents in the steel, petrochemical and electricity generating industries. It was on the basis of these successes that Professor Canter developed the investigative approach to applied psychology that is at the heart of his work with the police in 'offender profiling'.

Centre for Investigative Psychology the University of Liverpool
To develop his problem solving approach to real world problems Professor Canter set up the Centre for Investigative Psychology at the University of Liverpool in 1994. This runs an MSc and PhD programme as well as providing training and consultancy to law enforcement and related professionals throughout the world. The Centre has developed dedicated software to act as decision support tools for various areas of civil and criminal investigation.